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ABSTRACT

These case studies are written for educational institutions that wish to plan, extend, or improve their use of computers for learning and teaching. Each case study includes a brief description of each of the following: profile of the institution, history of the development of instructional computing, organization and management, student access to computing, cost and budgeting, student accomplishments, spectrum of applications, computer literacy, computer science, outreach, plans and goals, lessons learned, contracts, and references. (MP)

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Chicago Schools • Dallas Schools • A.I. duPont District • Huntington Beach High Schools • George Washington High • Lincoln High • North Salem High • Ridgewood High • Riverdale • Lawrence Hall of Science

ED166018

INSTRUCTIONAL COMPUTING . . .

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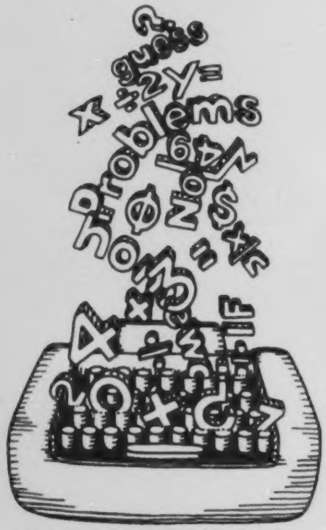

Design by Lawrence Hall of Science

Ten Case Studies

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SE 025 476

HumRRO
HUMAN RESOURCES RESEARCH ORGANIZATION

1978

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Foreword

This book was prepared by the Human Resources Research Organization and supported by the National Science Foundation Science Education Directorate, Grant Number SED-76-15399. Dr. Robert J. Seidel, Director of HumRRO's Eastern Division in Alexandria, Virginia, is Principal Investigator for the project, and Ms. Beverly Hunter is co-Principal Investigator. Ms. Carol Hargan is the case investigator for the precollege cases. Any opinions, findings, and conclusions or recommendations expressed in this book are those of the authors and do not necessarily reflect the views of the National Science Foundation.

The following people gathered the information on academic computing at their institutions:

Lincoln High School: James Burke, Technology Division Leader
Ridgewood High School: Marilyn Spencer, Computer Education Supervisor
Riverdale Country School: Bruce Alcock, Director of Computer Activities
George Washington High School: Irwin Hoffman, Computer Math Teacher
North Salem High School: Robert Jaquiss, Computer Teacher
Dallas Independent School District: Duane Dean and Dick Mallett, Telecommunications Supervisors
Huntington Beach Union High School District: Glen Dysinger, Assistant Superintendent for Planning, Research and Evaluation
Chicago Public Schools: Rita Cooney, CAI Project Director
Alexis I. duPont School District: Carl Hauger, Computer Project Director
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Introduction

This book describes instructional computing at ten precollege educational institutions. These case studies are written for administrators, teachers, staff and students who wish to plan, extend or improve the uses of computers for learning and teaching at their own schools.

The case study institutions include secondary schools, public school districts, a private school, and a science center for the general public.

We selected a range of different sizes and kinds of schools, distributed geographically around the United States, so that readers may find one that most closely resembles their own. Because the case study schools have been involved in instructional computing for over a decade, educators from other schools may learn from their experiences. Each case study includes a brief description of each of the following.

1. **Profile:** size, type, and location of institution.
2. **History:** significant events in the development of instructional computing, such as major equipment acquisitions, curriculum developments, staffing.
3. **Organization and Management:** who is responsible for instructional computing; incentives and training provided for teachers to become involved.
4. **Student Access to Computing:** what equipment is provided, where, when, and how.
5. **Costs and Budgeting:** who pays for instructional computing and what does it cost?
6. **Student Accomplishments:** highlights of the work accomplished by students as a consequence of using computers.
7. **Spectrum of Applications:** departments and courses using computers, and the kinds of computer applications used.
8. **Computer Literacy:** programs aimed at making the majority of students and/or faculty generally knowledgeable or skilled in the application of computers.

9. **Computer Science:** Vocational or college preparatory programs of study in computer programming, data processing, or other computer-related disciplines.
10. **Outreach:** how the institution shares its expertise, computer facilities, computer based learning materials, and other resources, with the local community or other schools.
11. **Plans and Goals:** planned improvements in equipment, organization, curricula, or programs.
12. **Lessons Learned:** highlights of the lessons that have been learned through experience.
13. **Contracts:** who to call for more information on specific areas.
14. **References:** document sources of additional information.

Selection of Cases

Case Institutions were selected through a four-stage procedure. First, we conducted a systematic search for institutions that are regarded as outstanding in their uses of computers for learning and teaching. Invitations were mailed to seven thousand educators and technologists who belong to professional organizations concerned with educational computing. These individuals were invited to nominate one or more educational institutions that they regard as outstanding. Nominators were asked to give specific reasons why the school should be considered, given the objectives of our study.

Over 500 individuals responded, nominating 370 institutions that met our criteria.[1] Eligible institutions included individual elementary and secondary schools, public school districts, community colleges, colleges, and universities, and public access institutions such as museums.

Second, we contacted, at each nominated institution, an individual who has a purview of instructional computing activities. In many cases, this individual is the Director of the Computing Center or a Coordinator of Instructional Computing. The nominated institutions were happy to participate, and provided information about their activities via a telephone interview with a member of our staff. The product of this stage is an Academic Computing Directory, published by HumRRO, that gives brief information on the reasons for nomination, enrollment, typical computer applications, make and model of main computer(s), number of terminals on campus, and persons to contact.

Third, the nominees were invited to respond to one or more of a series of open-ended questionnaires corresponding to the following Categories of Excellence:

1. Institutional Commitment to Instructional Computing
2. Student Accomplishments
3. Institution Productivity
4. Spectrum of Applications
5. Computer Literacy
6. Computer Science and/or Data Processing Programs
7. Outreach
8. Model

---

[1] Projects, consortia, timesharing companies were not eligible.

These questionnaires were quite lengthy and required considerable work on the part of the respondents. By completing one or more of the questionnaires, the respondents demonstrated their willingness and ability to share information. Over one hundred of the nominees responded in one or more categories of excellence. HumRRO staff then reviewed all candidate institutions within each Category of Excellence. We selected as Exemplars in each Category those institutions that had provided complete answers and had demonstrated a high commitment to instructional computing. Consulting experts were called upon to review candidates in specific Categories. The product of this third stage is a list of Exemplary Institutions distributed by HumRRO.[1]

Fourth, the Case Institutions were selected from among the Exemplars. The following criterion dimensions were used in selection:

1. High institution commitment to academic computing as demonstrated by the survival of instructional computing over several budget cycles; staff support for instructional computing; reform of curriculum to incorporate computer uses; increases in appropriate computing equipment; incentives to faculty for instructional innovation.
2. High degree of computer literacy among students, faculty and administration, as reflected in student accomplishments, spectrum of applications, and number of computer users on campus.
3. Appropriate response to the Model questionnaire, and usefulness of all questionnaire responses.

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[1] A list of the exemplars and twenty-one Case Institutions is provided as Appendix A.

Summary

THE CASE STUDY INSTITUTIONS

The precollege case study institutions range from a large city school district with over a half million students to a small private school of 950 students. The institutions, their enrollments and grade levels, are shown in Figure 1.

The majority of the schools and districts began instructional computing activities in the late 1960's. The proportion of students who access a computer some time during the school year ranges from about 4% to over 90% in these schools.

The institutions vary widely among each other in terms of the ways computers are used for learning and teaching and in terms of the resources expended for instructional computing. Some students use the computer perhaps an hour or two a year to receive vocational guidance; others use their computers a few minutes every day to receive drills in basic math and language skills. Other students use computers several hours every week to develop computer programs and solve complex problems.

The case study institutions are not necessarily the most advanced, successful, or effective in instructional computing in the U.S. They do provide a broad representation of state-of-the-art applications and equipment found in educational practice. While no single institution provides a comprehensive model to be adopted in toto by other schools, many aspects of their instructional computing activities provide useful lessons and guides to other educators.

OVER A DECADE OF INSTRUCTIONAL COMPUTING

The majority of our case study schools have been involved in instructional computing for over a decade. They have all found it to be a long, slow process to integrate computer use into the organization, the budget, the curriculum, and the classroom practices of teachers and students.

The case study schools and districts have all had some form of outside assistance in getting their computer projects underway. At least half

School District	1976-77 Enrollment	Grades	Year Computing Started	Estimated # Students Using Computers 1976-77	Estimated % Students Using Computers Annually
Chicago Public Schools, Illinois	513,000	K-12	1965	21,300	4%
Dallas Independent, Texas	140,000	K-12	1968	6,000	4%
Alexis I. duPont, Wilmington, Delaware	3,000	K-12	1968	1,610	50%
Huntington Beach Union California	20,000	9-12	1968	4,000	20%
School					
George Washington H.S., Denver, Colorado	2,000	10-12	1962	240	12%
Lincoln, H.S., Bloomington, Minnesota	1,800	9-12	1965	900	50%
North Salem H.S., Salem, Oregon	1,500	9-12	1968	750	50%
Ridgewood H.S., Ridgewood, New Jersey	1,600	10-12	1966	1,500	94%
Riverdale County School, Bronx, New York	950	K-12	1970	450	50%
Public Access					
Lawrence Hall of Science, Berkeley, California		K-adult	1969	27,000	

Figure 1. **Profile of Precollege Case Study Institutions**

of them received federal grants from the National Science Foundation and from the U.S. Office of Education. Others received help from computer manufacturers, regional and State computer networks, or universities.

Nearly all the case study institutions were able to tie into timesharing networks in the early stages of their computer activities. These included commercial timesharing networks, state and regional consortia, and university systems. Often these networks provided not only computer power, but also the instructional programs, teacher training, and technical expertise needed by the schools to get started. After an initial period of computing with this support, six of the schools and districts then went on to purchase or lease their own computers for instructional purposes.

Through many of the case histories we find a single key individual who not only initiated computer-related activities but also persevered despite administrative, financial, and technical obstacles.

ORGANIZATION AND MANAGEMENT OF COMPUTING

A wide variety of organizational and management arrangements are represented by the case institutions. As indicated in Figure 2, the computer facilities are controlled by the school district in most cases. In the case of Dallas, individual major projects control their own computers. George Washington High School owns several programmable calculators in addition to using the Denver Public School District's computer center. Lincoln High School uses a regional network, TIES. North Salem, Ridgewood, and Riverdale schools each have their own computers.

The computer facilities are shared between administrative and instructional applications in most of the cases. Ridgewood and A.I. duPont are the only two school districts that have computers dedicated to instruction. In the case of North Salem, the District's computer is used only for administration, and each school acquired its own instructional computers.

STAFFING

In at least half of the case study schools, the computer operations and programming staff consists primarily of high school students. In

School/District	Control of Computer Facilities Used for Instruction	Responsible for Instructional Computing	Reports to
Chicago Public School District	District	Bureau of Computer-Assisted Instruction	Dept. of Curriculum and Instruction Services
		Bureau of Computer Education	Dept. of Vocational and Career Education Program Development
Dallas District	District, plus Individual Projects	Individual Projects	Dept. of Research, Evaluation, and Information Systems
A.I. duPont District	District	Computer Project Director	Principal and Assistant Superintendent for Instruction
Huntington Beach Union High School District	District	Assistant Superintendent for Planning, Research, and Evaluation	Superintendent of Schools
George Washington High School	District, plus school-owned programmable calculators	Computer Math Teacher	District Supervisor of Mathematics Education and Curriculum Development
Lincoln High School	State Network TIES	Science Division Leader at Lincoln	Principal
North Salem High School	District	Computer Teacher	Principal
Ridgewood High School	District	Coordinator of Instructional Computing	Assistant Superintendent of Instruction, Principal
Riverdale Country School	School	Director of Computer Center	Headmaster of the School
Lawrence Hall of Science	LHS	Director of Computer Education and Operations	Director of LHS

Figure 2. **Organization and Management of Computing**

addition, each of the case study institutions has one professional person who devotes full time, or nearly full time, to instructional computing activities. This person may be a "Computer Teacher," a "Coordinator of Instructional Computing," or a "Computer Project Director." If a school has one main room where the computer terminals are kept, this room is usually supervised by teachers, student aides, or paraprofessional aides.

TEACHER TRAINING AND INCENTIVES

Computer literacy for the faculty has been an important aspect of the instructional computing activities of the case study instructions. The primary focus of the training is generally on computer applications that are useful to teachers in their classrooms.

In several cases, faculty have attended training programs at nearby universities. Graduate credit is obtained by participating in such courses.

Credit towards salary advances and promotions is sometimes provided as an incentive for faculty to participate in training programs and in curriculum improvements. Other incentives include paid memberships to professional organizations such as AEDS, ACM, computer users groups, and the like; paid travel to professional conferences and workshops on instructional computing; stipends for computer club activities; and the provision of technical support to faculty who want to improve their courses.

Teacher training in computer applications has been partially supported by federal grants and contracts in at least four of the case study institutions.

It has been found to be important in training teachers to make them aware that they do not have to become technical experts in computing and programming in order to use computer applications in their classwork. Teachers should have an opportunity to have hands-on experience with computer applications in the subjects they teach, rather than simply receiving instruction in programming.

COMPUTERS

The computers used for instruction in the case study schools are listed in Figure 3. Several of the schools use microcomputers and programmable calculators. Others are in the process of evaluating microcomputers for particular applications. At Ridgewood, for example, curricula are being developed for elementary school use of the Commodore PET; microcomputers for use in physics are contemplated. Ridgewood is also integrating the use of programmable calculators into the junior high curriculum. At George Washington, a pilot study is underway to determine whether to upgrade the central computer or to replace timesharing terminals with microcomputers. North Salem plans to acquire an additional microcomputer each year, including one with color graphics. Riverdale is studying the application of microcomputers as nodes on a network; they also plan to use color graphics and animation.

At least half the institutions have found it advantageous to maintain access to a regional or commercial network for applications that require special facilities, such as a retrieval system for career and college information.

TERMINALS

Figure 4 shows the ratio of student users per terminal, and student enrollment per terminal, for the case study institution. The wide variation in these ratios is a direct reflection of the kinds of computer usage employed. In George Washington High School, for example, students work intensively with the computer in the Computer Math curriculum; hence, a fairly low (40:1) ratio. At North Salem, by contrast, 700 students per year use the one terminal allocated to the guidance application. At Ridgewood, where nearly all students and many teachers are involved in computing, the availability of only ten ports has restricted the growth of instructional computing.

Most of the case study schools have found it advantageous to cluster the available terminals in a few locations, rather than spreading them out among schools and departments. It is too difficult for a classroom teacher to integrate the use of one or two terminals into the activities of an

	Lawrence Hall of Science	George Washington High School	Ridgewood High School	Riverdale School	Lincoln High School	North Salem High School	Chicago Public Schools	Huntington Beach District	Dallas School District	A.I. duPont District
Altair									2	
Apple II	16									
Burroughs 6700									1	
CCC A16									2	*
CDC Cyber 73					*					
Data General Eclipse	3									
Data General Nova	1									
DEC PDP 11	*		1	1					1	1
DEC PDP 8						1				2
DEC Classic						1				
HP 2000			*		*				1	*
IBM System 3									1	
IBM 370							1	1	*	
Imsai						1			2	
PET	15		1			1				
Processor Technology SOL	3									
TRS-80									2	
Univac 1110							1			
Univac 1130		*								

*Access to

Figure 3. **Main Computers Used for Instruction in Case Study Schools**

Institution	Enrollment	# Terminals or Ports (Instructional Use)	Locations	Annual # Users	Student Users Per Terminal	Student Enrollment Per Terminal
Chicago Public Schools	513,000	921 CAI	58 Elem. Schools 2 High Schools	10,000/day	11/day	475
		163 Computer Education	4 Elem. Schools 64 High Schools	8,500	53	
		14 Guidance		800	57	
Dallas Schools	140,000	118	31 locations including all high schools	6000	46	1,077
A.I. duPont District	3,000	15	1 High School (computer room)	1,610	70	130
		8	6 Elem. Schools			
Huntington Beach H.S. District	20,000	60	6 High Schools– 2 locations in each	4,000	66	333
George Washington H.S.	2,000	6+	Math Lab	240	40	333
Lincoln High School	1,800	7+	Open Science Lab Career Center Math Dept. Project Success	900	125	257
North Salem H.S.	1,500	1	Guidance Dept. (GIS)	700	700	300
		4	Computer Ed. Classroom	100	25	
Ridgewood H.S.	1,600	10+	Six locations in the H.S., including a Computer Resource Center	1,500	150	160
Riverdale School	950	15	Upper School terminal room; Middle School Math Lab; Lower School Math & Reading; 2 classrooms	450	30	63
Lawrence Hall of Science	NA	100	30 locations, many portable	30,000	300	NA

Figure 4. **Terminals, Locations, and Student/Terminal Ratios**

entire class of students. Similarly, some have found the allocation of just ten minutes per student per day on a terminal to be logistically impractical particularly where large numbers of students are involved.

COSTS AND FUNDING

Although many of the case study institutions benefitted from federal support in their early experience with computing, nearly all are now receiving their computing funds from local sources. In Chicago, the CAI activity (basic skills in reading and mathematics) is supported by Federal ESEA Title I funds, but the Computer Education program is locally supported. At Lincoln High School, the computing facilities and support are provided by the regional network (TIES), but the local district pays for the use of the network.

In many cases, this local support for instructional computing took many years to establish. Some of the schools and districts now enjoy the very positive support of the local governing boards. For example, in Huntington Beach a policy has been established that 1.2% of the school budget will be spent on computing.

While many school districts in the U.S. spend all of their computing dollars on administrative applications, one of the case study districts spends as much as 90% of the computing dollars on instructional computing. Dallas and Chicago, two large city school districts, allocate 24% and 28% of their total computing budgets to instructional as opposed to administrative applications.

The question, "What does it cost per student" is very valid and important. However, the schools do not maintain the kind of computer use and cost accounting data that would be needed to provide unambiguous answers to the question. In very general terms, the case study schools range from less than $4.00 per student user per year, to over $160 per student user per year. They range from an average of $1.25 per enrolled student per year, to $29.00 per enrolled student per year for instructional computing equipment, staff and materials. Lincoln, North Salem, and Huntington Beach are on the low end of the cost spectrum, each for a different reason as indicated in their case studies.

In Chicago, the cost of CAI was $112 per student per year in 1974-75. This application involves 20 minutes per day per student on-line. This system was determined to be cost effective for meeting the needs of students in Title I programs.[1] The highest per student cost was computed for George Washington High School where an in-depth program provides a limited number of students the opportunity to do advanced programming projects.

STUDENT ACCOMPLISHMENTS

The case study schools provide information on some of the accomplishments of students that result from computer use. These include:

- improved scores on tests of basic skills
- increased mastery of learning objectives
- improved attitudes towards school, learning, or self
- projects that benefit school and community
- awards
- employment

Although the schools provide computer-based tools to aid students in problem solving, little or no data were available to show the kinds of problem-solving skills the students are acquiring.

Basic Skills

Dallas, Chicago, and Ridgewood have studies showing increased achievement in mathematics, spelling, and language arts as a result of using drill and practice programs.

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[1] Educational Assessment Service, Inc. *Comparative analysis of three ESEA Title I reading and mathematics activities.* June 1976.

Mastery

Achievement gains and increases in concept retention have been reported for ninth grade students using a computer-managed instruction system developed at A.I. duPont.

Attitudes

Schools report improved attitudes towards science (duPont); increased attendance (Dallas); increased motivation of learning-disabled students (Lincoln); high interest and motivation for computer education students (Chicago); and increased interest in classroom mathematics (Riverdale).

Projects

The schools are proud of the projects students carry out using computers. Examples:

- A carpooling program, cited as outstanding by the U.S. Department of Transportation, which has aided over 500 corporations. (George Washington High School).
- A series of on-line programs to carry scoring and results of a county-wide academic decathalon. (Huntington Beach).
- System software, language processors, and instructional programs to run on the school's microcomputers. (North Salem).
- A Six-year drill and practice mathematics curriculum. (Riverdale).

Awards

Students at case study schools have achieved recognition and distinction for their computer work through:

- Science fair awards
- Presentations at national conferences (e.g., National Computer Conference, National Council of Teachers of Mathematics)
- College credits for computer science work
- Programming contest prizes
- Presentations and distribution of programs through computer users groups
- Scholarships

Employment

Some students at case study schools are employed by the school as instructors for staff development, programmers, and student aides in the school computer center. Others obtain summer or part-time employment with local business and industry.

Follow-up studies of graduates and their employment in computer-related careers are not comprehensive, although Lincoln High School now has such a study underway. Many students, as expected, have gone into computer-related careers as a result of their early exposure.

Applications

Nearly all the case study schools use computers for drill and practice, simulation, problem solving, guidance information retrieval, and instruction in programming. Other applications, not as widely employed, include data analysis, art design, on-line testing, computer-managed instruction, tutorials, language translation and voice synthesis, and word processing.

Applications involving the use of graphics have been very limited among the schools, but will increase as the schools are able to acquire the needed hardware and software to support such applications.

The computer applications are used to varying extents by nearly all subject areas, including art, business, English, languages, reading, mathematics, social studies physical education, music, sciences, guidance, home economics, library, industrial arts, and in extracurricular activities.

Most of the computer programs and associated curricular materials have been developed locally by the case study schools. Important exceptions are the widely used Computer Curriculum Corporations drill-and-practice programs in mathematics, reading, and language arts; the Huntington II simulations distributed by DEC; and guidance systems such as GIS and CVIS.

COMPUTER LITERACY

The concept of "computer literacy" includes the idea that all educated persons in our society need to have some understanding of computer-based systems and applications, and knowledge of how to use computers in their work. Operating under this concept, a school would either provide the opportunity for all interested students to learn about computers, or would require all students to take courses that incorporate computer use.

Only one of the case study schools, Riverdale, incorporates computer literacy into the required curriculum for all junior high school students. At Riverdale, this consists in a two-week unit in programming during 8th and 10th grade mathematics. At duPont, a 9-week elective course addresses the impact of electronic data processing on society, human-computer interface, computer-related careers, and computer applications. Some middle school students in the duPont District also learn about computing as part of their math courses.

The other case study institutions provide facilities and elective courses designed to introduce students, faculty, or administration to computer-related skills and knowledge. Nearly all of them plan to extend their computer literacy programs in terms of numbers of students reached and breadth of content.

Lawrence Hall of Science introduces about 30,000 persons a year to computing through their varied programs and courses addressed to both students and the general public.

COMPUTER SCIENCE

All the case study schools offer an elective curriculum in computer science, computer technology, computer math, or data processing. The most intensive vocational curriculum is offered by Chicago in Technical Centers in three of the high schools under the "Access to Excellence Plan." This four-year curriculum offers specializations in operations, business-oriented computer programming, and technical programming and computer architecture.

By contrast, the program at Riverdale is oriented towards computer skills students will need in college, such as computer applications in numerical analysis, economic forecasting, urban planning, and statistics.

As indicated in Figure 5, the computer science programs are most frequently administered by the Mathematics Department, while others are under the aegis of career education, science, or computer science.

School/District	Program Orientation	Grades	#Courses Offered	#Students/Yr.	Department
Chicago Public Schools	Computer Studies	9-12	14	220	Vocational and Career Education Program Develop.
	Computer Education Vocational		1 semester; 8 annual courses	8300	Varies by school; Science, Mathematics, Business
A.I. duPont District	Computer Science	9-12	4	150	Computer Science
Huntington Beach H.S. District	Varies by school: ● Computer Science ● Data Processing ● Computer Math ● Business Office	9-12	About 10	1200	Varies by school: ● Mathematics ● Business ● Science
Dallas Schools	Data Processing	9-12	7	200	Career Education
Riverdale School	Computer Science Academic Applications	11-12	5 half-year courses	35	Math
Ridgewood H.S.	Computer Science	10-12	2+	250	Math
Lincoln High School	Computer Technology (Three-quarter sequence)	9-12	3	180	Science
George Washington H.S.	Comp. Math (2-yr. prog.)	10-12	4 semesters	50-80/semester	Math
North Salem H.S.	Computer Programming	9-12	5	50	Math

Figure 5. **Computer Science Programs**

CHICAGO PUBLIC SCHOOLS
CHICAGO, ILLINOIS

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Chicago has two major components in its academic computer program: a computer-assisted instruction program for elementary students needing remedial help in reading, mathematics, and language skills; and a Computer Education program for high school students.

Profile

SIZE

Chicago is a large city public school system with more than 500,000 students in grades K-12.

Board of Education employees number about 50,000 including 27,000 teachers who staff 579 schools and 84 branches.

STUDENTS

The diversified student body is 24% white, 60% black, 13% Spanish speaking, 3% other.

From the graduates in 1977, 55.8% of the boys and 57.7% of the girls attended college.

CURRENT ISSUES

Chicago, similar to other large city systems, is facing declining enrollments, record budgets, a shrinking tax base, and inflation.

The Past Thirteen Years

The two major events in the history of academic computing in Chicago were the development of the Computer Education curriculum and the receipt of Title I funding for the Computer-Assisted Instruction program.

1965	Initiated Computer Education curriculum.
1966	Piloted Computer Education curriculum in three high schools.
1968	Established the Department of Systems Analysis and Data Processing. Field tested Arithmetic Proficiency Test Program, an early CAI program for elementary students.
1969	Formed NAUCAL (National Association of Users of Computer Applications to Learning) in conjunction with other educators. Performed planning study for CAI in the basic skills. Piloted Computer Education curriculum in three elementary schools.
1971	Received first Title I grant for CAI program. Held teacher in-service and training for aides. Implemented CAI program in seven elementary schools. Offered Computer Education courses in all high schools.
1974	Upgraded the computer in order to offer CAI in additional schools. Made author language (ASET) available.
1978	Continued the growth of the CAI program to serve 54 elementary schools plus six CAI laboratories in schools for handicapped students with 921 terminals. Expanded computerized vocational guidance program. Initiated four-year multipath career education program in three technical centers.

Organization and Management of Academic Computing

MANAGEMENT

The Bureau of Computer-Assisted Instruction, assigned to the Department of Curriculum and Instruction Services, is responsible for the CAI program.

The Bureau of Computer Education within the Department of Vocational and Career Education Program Development manages the Computer Education and Computer Studies programs.

Each bureau has a director:

Rita Cooney, CAI
Ted Gradolf, Computer Education.

Administrative computing and the operation of the computers used for learning and teaching are under the auspices of the Department of Systems Analysis and Data Processing.

The use of computer technology in education was developed in the Chicago Public Schools under the direction of Mr. Harry Strasburg, Assistant Superintendent of Schools. During his 10 years as head of the Department of Systems Analysis and Data Processing, he spearheaded the expansion of the Computer Education program at the secondary level and was responsible for the Computer Assisted Instruction program coming into existence. His role was always one of active involvement, and from the time in 1969 when he founded NAUCAL and served as its first president until the present time, he has given leadership to the development of these nationally recognized Educational Computer programs.

STAFF

Each CAI school has a paraprofessional to manage the computer laboratory.

FACULTY INCENTIVES

In-service education for administrative and teaching personnel is provided in two basic areas:

- computerized procedures and records
- equipment and procedures for Computer Education

In-service topics include:

- Computer-Assisted Instruction
- FORTRAN
- COBOL
- Operating system concepts
- Systems analysis
- Programming logic

CAI in-service covers:

- Drill and practice curriculum
- Integrating CAI with classroom activities
- CAI class reports for student evaluation
- CAI curriculum development

Student Access to Computing

COMPUTERS

UNIVAC 1110 for CAI

IBM 370/155 for Computer Education

TERMINALS

921 terminals for CAI

163 terminals for computer education

2 graphics terminals

14 terminals dedicated to use of the guidance system

Each CAI school has a computer laboratory with 15 CRTs and one line printer.

USERS

Approximately 21,300 total annual users: 10,000 CAI students use the academic computing facilities each day; 8,500 Computer Education students annually; 800 students use the guidance system annually. 2,000 students use the computers in various high school classes.

WHERE

Terminals in 127 locations.

CAI terminals in 58 elementary schools, and 2 high schools.

Computer Education terminals in 64 high schools, and 4 elementary schools.

Terminals in technical centers in three high schools.

HOW

Students at least one and one-half years below anticipated reading achievement, and eligible for Title I programs, are registered for CAI.

Each CAI student has a 20-minute terminal session daily. The computer laboratory is open 6 hours each day, and an aide is available to help students.

Computer Education students have free access to computer facilities 10 1/2 hours each day.

Costs and Budgeting

FUNDING

CAI is funded totally by an ESEA Title I grant. Computer Education is 100% locally funded.

BUDGET HISTORY

CAI:

1970-71	$ 15,000 (planning study)
1973-74	$2,580,156
1976-77	$ 961,009

CAI budget figures include staff, equipment maintenance, training, curriculum, license fee, instructional materials, supplies.

Computer Education:

1967-68	$440,000
1969-70	$550,000
1973-74	$650,000
1976-77	$653,224

Student Accomplishments

Student accomplishments are in the categories of:

- basic skills
- attitudes
- projects
- awards

BASIC SKILLS

Evaluation reports show achievement gains for CAI students.

Latest evaluation report [1] compares CAI to two other individualized instructional programs. CAI is shown to be more cost-effective in meeting the Title I objectives than the two other remedial programs.

ATTITUDES

High interest and motivation for Computer Education students as indicated by:

- Attendance: Computer Education students have above average attendance.
- Grades: Students, in general, receive grades in Computer Education courses that are higher than their individual averages.

PROJECTS

Students have developed various administrative computer programs.

AWARDS

Computer Education students have won science fairs, programming contests, scholarships, and grants.

REFERENCES: [1]

Spectrum of Applications

CAI

The CAI project provides drill and practice for Title I students in reading, mathematics and language arts. Each student in the CAI program is enrolled in reading and either mathematics or language arts. The three packages are commercially available from the Computer Curriculum Corporation; all use the Strands approach developed at Stanford University.

MATHEMATICS

Algebra. Computer units for problem solving.

Programming with Math and Science Applications.

Computer Architecture.

SCIENCE

Physics, Chemistry and Biology. Data collection, manipulations.

SOCIAL SCIENCE

Economics. Simulations and Games.

BUSINESS

Data Processing, Accounting, and Business Computer Programming.

GUIDANCE

CVIS, a vocational and College information retrieval system.

Computer Literacy

There is no formal computer literacy program for students other than the sequence of courses in the Computer Education curriculum, and the Computer Studies program in the Access to Excellence Plan.

Computer Education

FOR

Interested students in all high schools and 4 elementary schools.

8563 students were enrolled in Computer Education in 1977.

Approximately 220 students are enrolled in a new program, Computer Studies, that is one component of Chicago's Access to Excellence Plan.

BY

One to six faculty members per school from science, mathematics and/or business departments.

Large schools have a Computer Education department.

SINCE

1965 for Computer Education

1978 for Computer Studies

PROGRAM

Nine courses offered through science, mathematics and business departments (1 semester, 8 annual courses) in the Computer Education program.

Even more in-depth is one component of the Access to Excellence Plan, the Computer Studies program, a four year, sequential program designed to provide learning experiences for high school students preparing for entry into various categories of computer-related occupations. Heavy emphasis is placed upon career education that will place young adults in a favorable position within the job market upon graduation from high school. Provisions also exist to accommodate the student who will concentrate on computer-related studies in advanced learning institutions.

Students who participate in this program and leave school prior to graduation do so with enhanced employability.

The Access to Excellence student is one who has been recruited by the school for participation in the four year program. The Computer Education student, on the other hand, is one that exercises the option to study a computer related subject as one of the available electives offered by the school. The Access to Excellence students will be involved in computer studies throughout their high school careers; the Computer Education student is most likely to participate in a computer related subject only one or two years. Both student types will be accommodated at each school

The curriculum offerings of the Computer Studies program initially provides for three career paths. Each path will begin with a common introductory course and will terminate with a work experience course. Through ongoing counseling, testing, performance evaluation, and self determination each student will be guided into an area of concentration. Opportunities will exist thereafter for students to change career goals. These paths will be: (1) clerical and operations, (2) business-oriented computer programming and elementary system analysis, and (3) technical computer programming and computer architecture. Figure 1 illustrates the curriculum tree indicating the course offerings for each career path during the four years of high school attendance.

COURSE DESCRIPTIONS FOR COMPUTER STUDIES

Introduction to Data Processing

Grades 9-12 1 Unit Annual Course

This course surveys the field of data processing and provides an insight into the function of electronic computers in processing data. Fundamental concepts of machine functions, computer organization, systems design, and programming are presented. In addition, the many kinds of career opportunities available in data processing are explored.

Prerequisite: None.

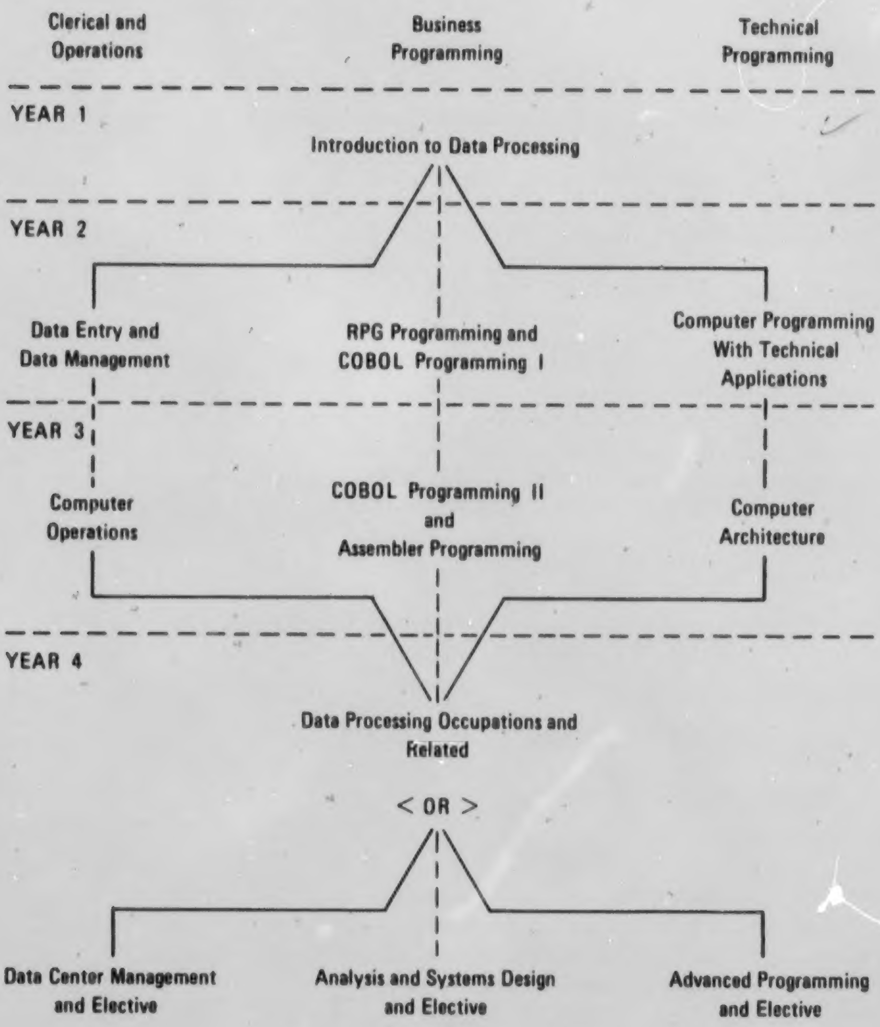
Clerical and Operations
Business Programming
Technical Programming
YEAR 1
Introduction to Data Processing
YEAR 2
Data Entry and Data Management
RPG Programming and COBOL Programming I
Computer Programming With Technical Applications
YEAR 3
Computer Operations
COBOL Programming II and Assembler Programming
Computer Architecture
YEAR 4
Data Processing Occupations and Related
< OR >
Data Center Management and Elective
Analysis and Systems Design and Elective
Advanced Programming and Elective

Figure 1. **Computer Studies Curriculum**

Data Entry

Grades 10-12 .5 Units Semester Course

This course provides the opportunity to develop a marketable level of skill with various contemporary data recording devices through appropriate training exercises and hands-on experiences.

Prerequisite: None.

Data Management

Grades 10-12 .5 Units Semester Course

This course presents the concepts of and various techniques involved in creating, verifying, and maintaining large data files. Sufficient hands-on experience is provided on various input/output devices and with a variety of secondary storage media to develop a marketable level of skill in the area of data control and data management. Opportunities to maintain skill levels previously developed are presented

Prerequisite: Data Entry.

RPG Programming

Grades 10-12 .5 Units Semester Course

This course introduces a report generation programming language. Practical experience is gained utilizing this non-algorithmic language to produce detailed and summary reports of data files.

Prerequisite: Introduction to Data Processing.

Introductory Computer Programming with Business Applications

Grades 10-12 .5 Units Semester Course

This course presents the basic syntax and structure of a familiar business-oriented computer language. Structured design and programming is emphasized in creating computer solutions to such business problems as recordkeeping, inventory, payroll, and sales analysis.

Prerequisite: Introduction to Data Processing.

Advanced Computer Programming with Business Applications

Grades 10-12 .5 Units Semester Course

This course enhances computer programming techniques and introduces advanced features of the programming language presented in the introductory semester. Programming applications will involve common commercial data processing file organizations and data structures.

Prerequisite: Introductory Computer Programming with Business Applications.

Assembler Language Programming

Grades 11-12 .5 Units Semester Course

This course introduces the structure and the basic instruction set of an assembly language. Programming exercises involve common business applications.

Prerequisite: Introductory Computer Programming with Business Applications.

Computer Programming with Technical Applications

Grades 10-12 1 Unit Annual Course

This course presents advanced mathematical and technical concepts through the use of the computer as a computational tool. Programming concepts and techniques utilizing a technically oriented computer language are stressed.

Prerequisites: Algebra and either an advanced mathematics course or concurrent enrollment in an advanced mathematics course.

Computer Architecture

Grades 11-12 1 Unit Annual Course

This course is designed to offer the opportunity to examine electronic computing hardware and the related and underlying mathematical, scientific, and technical principles. Students will gain a more complete understanding of binary numbers and logical operations and their implementation in electronic circuits.

Prerequisite: Computer Programming with Technical Applications.

Computer Operations

Grades 11-12 1 Unit Annual Course

This course provides for indepth specialization in the field of computer operations. Analysis of various operator functions directly associated with the maintenance of a data processing center is enhanced by the availability of hands-on experience with locally installed equipment.

Prerequisite: Data management or two semesters of computer programming courses.

Individualized Computer Center Experiences

Grade 12 1 Unit Annual Course

This course provides the opportunity for the advanced clerical and operations student to assist in the daily maintenance of the school's Computer Studies laboratories. Practical experiences gained will be augmented by comparative case studies of representative data processing centers.

Prerequisite: Three years of Computer Studies courses including Computer Operations.

Individualized Computer Programming Experiences

Grade 12 1 Unit Annual Course

This course provides the opportunity for advanced computer programming students to enhance their programming experiences through participation in major projects. Under supervision, students will design, implement, and maintain program solutions in appropriate computer languages for selected applications.

Prerequisite: Three years of Computer Studies courses including two semesters of computer programming.

Analysis and System Design

Grade 12 1 Unit Annual Course

This course provides the advanced computer programming student the opportunity to participate in the total design of selected application systems. Concepts and analysis of system design will be studied and a job control language will be introduced as required to implement various applications on a given computer system.

Prerequisite: Three years of Computer Studies courses including two semesters of computer programming.

Data Processing Occupations

Grades 11-12 2 Units Annual Course

These advanced courses form a program to provide paid occupational experiences involving the school and the business community. The classroom portion of the program is a transitional course which presents experiences leading to data processing careers. The associated work program provides practical participation in a data processing environment.

Prerequisite: Introduction to Data Processing.

IMPACT

A follow-up study of graduates taking Computer Education [4] shows:

5.1% directly enter work force in computer technology.

20.6% enter a computer-related field.

COST

Local funding with reimbursement from the State Department of Vocational Education. Unreimbursed cost is $15/student/year for equipment and communications.

COMPUTER-BASED LEARNING MATERIALS

Curriculum guides developed by Chicago school faculty have been disseminated to other school districts.

EXPERTISE

Case history of the CAI project was completed for the National Institute of Education [8].

Chicago staff has consulted with other schools pertaining to the in-service education for teachers.

Chicago staff has made presentations on the CAI project at AEDS, NAUCAL, ADCIS, NEA, Florida Council of Teachers of Mathematics, Illinois AEDS, and the Council of Great City Schools.

They have hosted visitors from all over the United States, as well as Japan, Israel, South America and Europe.

Plans and Goals

An extensive career education program in Computer Studies was implemented beginning in September of 1978 as a part of Chicago's Access to Excellence plan.

It is anticipated that by 1983, 1200 students annually will participate in this program.

An additional career path in the area of computer repair is under development and will be introduced at a later data.

CURRICULUM

Tutorial CAI curriculum is being developed in Chicago and, in the future, will be expanded to include instructional material for bilingual students.

An immediate goal for the CAI staff is to undertake a Computer Managed Instruction program at the elementary level which will perform the record keeping for the Continuous Progress Mastery Learning program.

45

Lessons Learned

ORGANIZATION

The Computer-Assisted Instruction program was developed jointly by educators, administrators, curriculum personnel, and data processing experts. This combination gave the program its strength at the start and provided for its continual growth.

A case study tracing the planning and development of the Computer-Assisted Instruction program in Chicago was written for the National Institute of Education. This document contains the rationale for all the decisions made and notes any changes which have taken place in the original configuration [8].

CURRICULUM

After an analysis of the various kinds (e.g., simulation, problem-solving, tutorial) of computer-based instruction, the Chicago personnel decided that drill and practice programs would be the most cost-effective means of meeting their students' needs. Their reasons follow:

> "This drill and practice kind of CAI required only that the student have a basic vocabulary which allowed him to read a simple sentence. Investigation revealed that the discouragement and disinterest which characterized the remedial student was replaced by active participation in the learning process in drill-and-practice CAI. Practice material of this nature had been written and was available for use. This type of CAI program enabled the teacher to monitor student performance constantly and to analyze the results of his performance so that instructional sequence was molded to individual needs.
>
> Drill-and-practice CAI was the easiest to implement and was a logical first step into a new field of instruction. It provided the staff with an opportunity to gain in experience and it fulfilled the requirements of a CAI program for students who lacked basic skills."
> (p. 18-19)

The Chicago staff found the Strands Approach of the Computer Curriculum Corporation's instructional materials to be the most appropriate for Chicago's students because of the way the materials are classified, presented, and varied for each individual.

FUNDING

ESEA provided Title I funds to establish, expand, and improve programs designed to meet the special needs of economically deprived children attending either public or non-public schools. In addition, special funds were available under the Urban and Rural Schools provisions of Title I for pre-school and elementary programs in areas with the highest concentration of children from low income families. Funding under Title I was not restricted to a specific time frame and grants could be renewed on a yearly basis for those programs which were shown to be effective. The Title I population to be served was exactly the same target population for which the CAI system was being designed. Funding under this Act meant that more children could be served since large grants were available.

LOCATION OF TERMINALS

Whether to distribute terminals throughout the school or to centralize their location in a dedicated room was studied by the Chicago staff. Placing one or two terminals in many classrooms made the scheduling simpler for the students and teachers in rooms where the terminals were installed. However, the students in those rooms would use the equipment for only a portion of the day and the remaining time would have to be allocated to students from classrooms that did not have terminals. The host rooms would be subject to movement of students in and out of the terminal area for the entire day. This distribution also required that the host teacher be on call when needed to assist students at the terminals. This problem could have been alleviated if personnel were assigned to each terminal area but this solution increased the cost for CAI. Where this kind of distribution was employed, investigation revealed that the terminals were not being used to maximum efficiency.

Thus, a CAI laboratory containing fifteen CRT terminals and a printer was established in each school. Serving one-half a class at a time was the most economic and flexible manner of providing student instruction. Since the laboratory was to be used by students for CAI sessions only, it was decided that a teacher aide could manage the program.

Contacts

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6. *SMPL2. A Simple Simulated Machine Programming Language.* Bureau of Computer-Based Instructional Systems, Chicago Public Schools, Chicago, Illinois.

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8. Strasburg, H., Cooney, R., and Litman, G. *Case History: Computer Assisted Instruction in Chicago.* A Report to the National Institute of Education, 1975.

9. *Teacher Aide Guide to Computer Assisted Instruction.* Board of Education. Chicago, Illinois.

10. *Telebriefs.* Illinois Bell Newsletter. Vol. 33, No. 2.

Curriculum Guides

The following publications of the Board of Education are used in the Computer Education program. They were prepared by the Department of Systems Analysis and Data Processing.

SMPL2:	A Simple Simulated Machine Programming Language
RXBOE1:	A Computer Machine Programming Language Simulator
RXBOE1	Programming Techniques (1971)
RAX Time:	Sharing Users Manual
RAX Context Editor	
Curriculum Guide:	COBOL Programming and Applications
Curriculum Guide:	Computer Programming with Mathematics and Science Applications (1970)
Curriculum Guide:	Introduction to Data Processing (1976)
Curriculum Guide:	FORTRAN Programming Supplement for Introduction to Data Processing (1971)
Curriculum Guide:	Punched Card Concepts and Keypunch Operation
Introduction to ATL:	Available Spring 1971

DALLAS INDEPENDENT SCHOOL DISTRICT
DALLAS, TEXAS

Dallas Independent School District has various instructional computing projects to meet the needs of the diverse student body.

SIZE

Dallas Independent School District (DISD) is a public, urban school district of 140,000 students, grades K-12, and 14,000 employees.

The student/teacher ratio is 27 to 1.

District includes 135 elementary schools, 27 middle schools, 19 high schools and 6 magnet (career) schools.

STUDENTS

Students are 46% black, 40% white, 14% Mexican American.

Students are from families in a wide range of incomes.

72% of the graduates attend college.

CURRENT ISSUES

Due to the decline in the annual standardized test scores, DISD is concentrating on developing basic skills for students.

Similar to many other city school districts, Dallas' enrollment is declining; but unlike many districts, Dallas' major problems are not financial.

Dallas is striving to provide equal educational opportunity for all students. Busing was ordered by the courts for DISD in 1971 and 1976.

The Past Ten Years

Instructional computing began in 1968 with the help of a National Science Foundation grant. Since that time, several varied instructional computing projects have been initiated to meet the diverse needs of the students.

1968	Received National Science Foundation grant to enrich the teaching of mathematics by using the computer. Purchased 10 teletypes; leased computer time from General Electric. Initiated teacher training.
1969	Joined the Region 10 Educational Service Center in Richardson, Texas which provided computer time and support to school districts in the area.
1970	Purchased their own computer, a Burroughs 5500 for research, administration and instruction. Made terminals available in all high schools.
1971	Hired full-time staff member to oversee instructional computing from the Data Processing Department. Initiated State-wide CAI program for the deaf.
1973	Purchased a Burroughs 6700. Purchased an IBM System 3 for Skyline, a career development center.
1975	Initiated the Bilingual Project.
1976	Acquired 6 terminals, VOTRAX units and 6 microprocessors for the implementation of the Bilingual Project. Acquired 2 additional computers to provide drill and practice in basic skills.

Organization and Management of Academic Computing

All administrative and research applications, as well as some instructional computing are under the auspices of the Data Processing Department.

MANAGEMENT

Most instructional computing projects in the Dallas Independent School District fall under the control of the Department of Research, Evaluation and Information Systems. Each project (e.g., Skyline, Deaf, bilingual) has its own organization and management (see Student Access section).

Use of the Burrough's computer and some drill and practice in the basic skills is administered through the Data Processing Department. Since the Data Processing Department's primary responsibility is administrative applications, it has been proposed that moving these functions to the Curriculum Department would not only be appropriate but indicative of upper management support for instructional computing.

STAFF

Two full-time staff members in the Data Processing Department are responsible for CAI. They are:

Telecommunications Coordinator, and
Math CAI Coordinator.

FACULTY TRAINING

Computer training (primarily for math teachers) has been offered since 1968. This training is not yet a part of Dallas' regular in-service training.

Proposals have been made to include computer training in the in-service program, as well as to require computer training for teacher certification.

Monthly staff meetings are held by staff from the Data Processing Department for faculty using computer-based materials.

Student Access to Computing

Access to computing is dependent on the system or project in which a student is involved.

COMPUTERS

Data Processing Department: Burroughs 6700
Skyline Center: IBM System 3
Access to Region 10 Education Service Center's IBM 370/158
Bilingual Program: DEC PDP 11/34, 2 Altair, 2 IMSAI, 2 Tandy TRS-80
Deaf Project: CCC A16
Oliver Wendall Holmes: HP 2000
Mark Twain: CCC A16

TERMINALS

Data Processing Department: Total 60 terminals (primarily teletypes); minimum of 1 terminal at each high school.
Bilingual Program: 6 CRTs with VOTRAX voice synthesizers
Deaf Project: 20 terminals
Oliver Wendall Holmes: 32 terminals
Mark Twain: 12 terminals

USERS

46 annual student users for each terminal, assuming 130 terminals for approximately 6000 students each year in all projects.

HOW

In general, account numbers are assigned to faculty who then issue them to students.

WHERE

Terminals in 31 locations in the District, including all high schools.

Costs and Budgeting

FUNDING

Academic computing under the auspices of the Data Processing Department is funded by 8% Federal, 10% State, and 82% local monies. Instructional computing comprises about 24% of the total Data Processing Department budget.

BUDGET HISTORY

Approximate figures from the Department of Data Processing:

1967-68	$ 67,500
1969-70	$108,000
1973-74	$192,500
1976-77	$666,000

Costs include equipment, maintenance, supplies, and personnel.

Student Accomplishments

Student accomplishments are in two categories:

- basic skills
- attitudes

BASIC SKILLS

Two studies have been completed [1, 4].

Students in grades 4-6 increased their achievement in mathematics by using either commercial drill and practice programs or those developed in-house.

ATTITUDES

At O.W. Holmes Middle School there was a 14% increase in the attendance rate for those students using the drill and practice programs versus those not using the computer.

REFERENCES

[1, 4].

Spectrum of Applications

The spectrum of applications is described for each project. In summary, 65 out of 6400 teachers are involved with computing; 6,000 out of 140,000 students.

DATA PROCESSING DEPARTMENT

MATHEMATICS

Drill and practice in grades 4-8; on-line testing system for junior high students. Algebra, Geometry, Trigonmetry and Calculus: problem-solving applications.

SCIENCE

Simulations in physics and chemistry; nomenclature in chemistry.

SOCIAL STUDIES

Geography drills, simulations.

ENGLISH

Sentence structures, parts of speech, poetry.

SKYLINE CENTER

COMPUTER SCIENCE

Comprehensive set of courses offered at Skyline Center, including BASIC, COBOL, FORTRAN, Logic.

BILINGUAL PROGRAM

SPANISH – ENGLISH

An experimental project in which students use the computer and associated voice synthesizers for translation and spoken Spanish and English.

DEAF PROGRAM

MATHEMATICS – READING – LANGUAGE ARTS

Deaf students throughout Dallas County uses the computer for drill and practice in the math, reading, and language arts. The curriculum is leased from Computer Curriculum Corporation in Palo Alto, California.

COMPUTER-ASSISTED INSTRUCTION IN ELEMENTARY AND MIDDLE SCHOOLS

READING – LANGUAGE ARTS – MATHEMATICS

General-purpose computer-assisted drill and practice in reading, mathematics, and language arts is available at 44 student stations in five schools serving 1,584 students, grades 4-8, daily.

The drill and practice mathematics programs recently implemented in the Dallas schools are offered by two different Computer-Assisted Instruction (CAI) systems that use three different kinds of curriculum. The Computer Curriculum Corporation (CCC) system provides instructional services via twelve terminals located at the Mark Twain Vanguard School. The Hewlett Packard (HP) CAI system provides instructional services via eight terminals located at the Holmes Academy, eight terminals at the P.C. Anderson Academy, twelve terminals at the M.H. Jackson

Vanguard School, and four terminals at the Polk Elementary School. The CCC system uses its own curriculum, i.e., CCC mathematics, reading, and language arts materials, while the HP system uses its own mathematics materials or the ICSP mathematics program supplied by the TimeShare Corporation as well as the CCC reading and language arts curricula. The objective of the project is to increase mathematics and reading performance of students by providing ten minutes per day of CAI drill and practice.

ICSP Mathematics is presented using a topical approach. Elementary mathematics is broken into 11 topics which cover grades one through six. The student enters the curriculum at the first topic which consists of whole number addition. A pretest is presented and if the student completes the pretest perfectly, he is advanced to the pretest for the following topic: whole number subtraction. This cycle continues until the student is not able to perfectly complete a pretest. That is the topic within which the student then begins to receive drills. The student is automatically sequenced through the drills at a rate based on his performances in previous drills.

HP Mathematics is presented using a modified strand approach. Elementary mathematics is broken into 15 strands that cover grades one through six with each grade having 24 blocks of instruction. Figure 1 presents the paradigm for sequencing in the HP curriculum.

The student enters the curriculum at the particular mathematics grade equivalency appropriate for the student. The student is sequenced through the blocks of instruction based upon previous performance. Any block that a student fails to master is scheduled for review at a later date.

CCC Mathematics is presented using a strand approach. Elementary mathematics is broken into 14 strands which cover grades one through six. The student enters the curriculum at the particular mathematics grade equivalency appropriate for the student. The student is automatically sequenced through the drills based upon performance in previous drills and may be temporarily assigned to a strand so that he may receive drills on particular concepts.

The purpose of the Oliver Wendall Holmes Middle School project is to provide enrichment for inner city students. In addition, Dallas

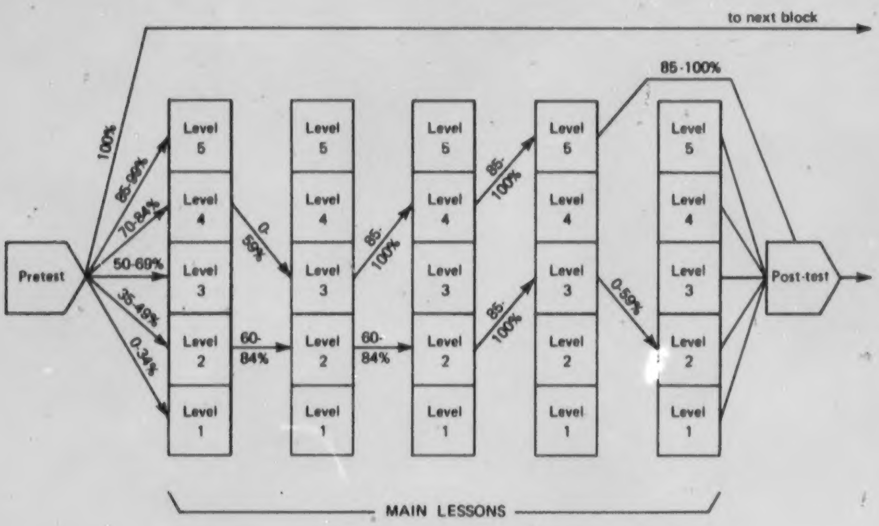

Figure 1. **Progress Through Curriculum Block**

personnel hope this project will convince more white children to attend these urban schools.

Advanced students at the Mark Twain Vanguard School use the computer for drill and practice in an individualized study area. This project is studying the advantages and/or disadvantages of providing most of the instruction via computer.

Computer Literacy

FOR: Interested high school students.

BY: Teachers in Math, Science and English departments who have integrated the use of the computer into their courses. The program is supported by the DISD Data Processing Department.

SINCE: 1968

PROGRAM: Main topics include computers and society, problem-solving with computers, and programming in BASIC, FORTRAN AND COBOL.

IMPACT: Growth of instructional computing (all projects):

	Students	Teachers
1970	20	9
1973	200	20
1974	1000	35
1975	4000	50
1977	6000	65

Computer Science

FOR:	200 students each year
BY:	Career Education Department
SINCE:	1971
PROGRAM:	The program is geared to job placement and/or college.

1400 academic hours are offered in the Computer Science cluster at Skyline Center.

Modules in the cluster include:

- Fundamentals
- Programming
- Operations
- COBOL
- Advanced Programming
- Mathematics for Data Processing
- BASIC
- Advanced BASIC

Student assignments are often work-related case studies.

First Year. The concentration during the first year stresses Introduction to Computers, Data Control, and Basic Programming. All students take the Introduction to Computer phase which exposes them to general concepts, programming, language, and computer functions. After completion of the first phase of training, students can choose between Programming, Operations, or Data Recorder, depending on their interest and aptitudes.

Second Year. This is a continuation of the first year's curriculum. In addition to the basic curriculum, an on-the-job-training module is available to selected second-year students. This module gives the student an opportunity to gain experience and additional knowledge about computer sciences as a career. Upon completion of the two-year program, operations students are trained to operate Unit Record equipment, decollator, and burster, an IBM System 3 model 10 with a 1442 card reader/punch. They will also be able to perform as data control clerk and tape librarian. Data Recorder students are trained to operate the 029 Keypunch and the

059 Verifier. Programming students are able to perform as BASIC, COBOL, FORTRAN, and RPG and Assembler language programmers.

IMPACT: Career Opportunities

- Computer Programmer
- Computer Operator
- Data Librarian
- Data Control Clerk
- Systems Analyst (Higher Education)

Placement follow-up information is available [3].

FUNDING: 50% local; 50% State and/or Federal.

Outreach

COMPUTER-BASED LEARNING MATERIALS

Contracts have been drawn up and marketing arrangements made to allow other institutions to use Dallas' Bilingual materials and computer system configuration.

COMPUTER FACILITIES

The computer facility that houses the deaf program is used by deaf students throughout Dallas County.

EXPERTISE

Dallas personnel are members of various professional societies. They have made presentations on the CAI programs.

Workshops are offered to faculty from other institutions.

COMMUNITY SERVICES

GED and adult reading programs are available for community use.

Data are exchanged among DISD, local businesses and government.

ORGANIZATION

The Director of Data Processing believes that upper management should provide the leadership for instructional computing, but not to the extent of compelling the installation of unwanted or unnecessary programs. Too many "computer boondoggles" have been foisted upon the schools.

EVALUATION

It is important to initiate evaluation at the time a project begins in order to have comparative documented evidence of a program's benefits as well as its costs for future budget and equipment allocations.

Plans and Goals

During the 1978-79 school year, the curriculum development function was placed under the control of the Department of Research, Evaluation, and Information Systems. It is too early to tell what kind of impact this will have on instructional computing in DISD or to even discuss future plans. At the very least, this could cause an increase in the use of computers in the classroom.

Contacts

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Oliver Wendall Holmes Middle School	John Davis
Stonewall Jackson Elementary School	Janice Shipley Deaf Project
Region 10 Education Service Center Richardson, Texas	Carol Louis
Arlington Public Schools Arlington, Texas	Duane Dean

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ALEXIS I. duPONT SCHOOL DISTRICT
GREENVILLE, DELAWARE

Alexis I. duPont has an active computer project in the District and administers a state-wide computer-assisted instruction network.

*This case study describes instructional computing in the "former" Alexis I. duPont School District. As of July 1, 1978, Alexis I. merged with 10 other districts in the county to form the New Castle County School District.

SIZE

Public school district of approximately 3000 students, K-12; 321 staff members.

The District has one secondary school, grades 9-12; two middle schools, grades 5-8; and four elementary schools, grades K-4.

LOCATION

The District is located outside of Wilmington in one of the most affluent areas of the state in terms of property values, primarily the estates of the duPont family.

STUDENTS

Students are primarily from middle class families. The student body is 75% white and 25% minority, primarily black. Many of the minority students are from other districts on a voluntary transfer program established to help avoid court-ordered busing.

Approximately 80% of the students attend college.

CURRENT ISSUES

The District is governed by five-member school board, appointed rather than elected. Alexis I. maintains a small central administration including a superintendent and two assistants.

Specific goals for the district were developed in 1975 by a special project.

The merger with other districts is causing many uncertainties in such areas as organization, curriculum standardization, and survival of special programs.

The Past Ten Years

The formation of Project DELTA in 1968 was a major factor in the growth of instructional computing in the Alexia I. duPont School District. Significant expansion of their program occurred in 1976 with funding of their Title IV-C Computing Proposal.

1968	New high school building occupied. EDTECH project (using an IBM 1130) was absorbed by the Delaware School Auxiliary Association (DSAA). Project DELTA, a state-wide network was formed by DSAA. Alexis I. acquired one terminal into DELTA, used for exploratory purposes, with no structured activities.
1969	Second terminal added. Teacher attended summer workshop at the University of Colorado on Algebra II with Computer Programming. Computer Club formed with the purpose of providing instruction in programming to students.
1970-72	Terminals used for Algebra II course.
1973	Middle School acquired terminal. Gifted middle school students (2/grade) learned programming. Science CMI curriculum used. Two more terminals acquired. Students rather than teachers became the programming instructors for the computer club.
1974	Entire 9th grade used Science CMI system. Voters did not pass a referendum for increasing school taxes; this defeat caused the middle school program to be dropped.
1975	GIS available through Project DELTA. duPont Company donated DEC PDP 8S and 8I to the Middle School. Business Education personnel attended a workshop and made plans to integrate computing into their courses.

1976	Title IV-C proposal funded. Computer Science curriculum started. Alexis I. acquired their own DEC PDP 11/34 computer and 12 terminals.
1977	Alexis I. received continued support from Title IV-C. Teacher training at Alexis I. was initiated. The District agreed to administer a State CAI network, known as Project DIRECT.
1978	Computer Architecture course taught. Title IV-C funding again received to continue program expansion.

Organization and Management of Academic Computing

The primary mission of the Computer Project in Alexis I. is instructional computing. As their expertise has increased, the staff has begun to develop administrative applications (e.g., report cards).

MANAGEMENT

Computer Project Director, Carl Hauger, manages the Title IV-C project, teaches Computer Science courses, and oversees the operations of the computers.

The Computer Project Director reports directly to the Principal and the Assistant Superintendent for Instruction.

STAFF

Students help with programming and computer operations. Student employees are paid via student activities fund.

A secretary, a technical assistant, the Computer Project Director, and teachers monitor the high school's computer room.

COMMITTEES

A Computer Advisory Committee was established in 1976 to advise the district on activities and future plans, and develop a computer awareness survey and guidelines for high school vocational data processing. Committee members include administrators, community members, computer professionals, and computer instructors.

FACULTY TRAINING

Faculty have attended training programs at the University of Delaware since 1961.

Salary credit and/or graduate credit was obtained by participation in these programs.

Title IV-C grant proposed to expose all the high school teachers to various instructional uses of the computer during 1977-78. Students provided many of the demonstrations for these teachers. Advanced training for teachers in 1978-79 will be provided in all subject areas.

Student Access to Computing

COMPUTERS

DEC PDP 11/34	(Alexis I. duPont High School)
HP 2000 Access	(State network)
DEC PDP 8I	(Middle School)
DEC PDP 8S	(Middle School)
Access to CCC A16	(State network)

TERMINALS

Alexis I. duPont High School: 15 terminals

7 ADM3
3 Beehive B-100
1 DEC VT52
2 DECwriters
1 Compucolor (an 8-color graphics CRT)
1 HDS Concept/APL

Middle and elementary schools:

5 terminals to the HP 2000
2 terminals to the CCC A16
1 terminal to the DEC PDP 11/34

USERS

Approximately 70 annual student users for each terminal, assuming 1610 annual users for 23 terminals.

WHERE

The terminals in the high school are located in the computer room.

HOW

Account numbers in the PDP 11/34 are provided automatically to students enrolled in Computer Science courses. Any other individual requesting it may obtain an account. Accounts are also provided to users from the State network who request them.

Terminals in the high school's computer room are scheduled on a priority basis for teachers, computer science students, and others.

The computers operate 24 hours a day. Students may borrow terminals for home use.

Costs and Budgeting

FUNDING

Computing in the Alexis I. School District is supported by 50% Federal funds and 50% local funds.

Instructional applications comprise 90% of the computing budget.

BUDGET HISTORY

1976-77	$88,000
1977-78	$92,700
1978-79	$78,200*

Budget figure includes equipment, maintenance, staff and supplies.

INSTITUTION PRODUCTIVITY

An internal study for the Alexis I. duPont School District established the cost-effectiveness of the CMI Science system [13].

A summary of the results of this study follows:

> Three approaches to individualized instruction were considered. For these the various evaluation tasks were handled by 1) the teaching staff, 2) paraprofessional aides, and 3) a computer. To maintain the same level of individual contact with students the first alternative required the hiring of additional staff to reduce class size. The second alternative of using paraprofessionals was able to maintain the same teaching staff size by hiring aids in the student evaluation process. This roughly paralleled the third alternative which instead employed a computer. These were then compared to the base costs of what was actually being spent without efforts to individualize

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*1978-79 is the first year that duPont will not be purchasing hardware.

instruction. The ratios of these expenses to base costs were found to be as follows:

base line costs	1.00
teacher managed individualized instruction	2.07
paraprofessional managed individualized instruction	1.39
computer managed instruction	1.16

From these studies it was shown that the CMI approach was both advantageous to student learning and cost effective. A significant increase in retention was found to result from computer managed instruction. Perhaps more importantly it was found that student attitudes toward the learning of science actually increased as the year progressed instead of declining as expected. Therefore, a decision was made by Alexis I. duPont High School to expand this form of instruction to the entire ICP course. [14]

Student Accomplishments

Student accomplishments in the categories of:

- learning objectives mastery
- attitudes
- employment

LEARNING OBJECTIVES MASTERY

Achievement gains and measurable increases in concept retention have been reported for ninth grade students using a Computer-Managed Instructional system developed by Alexis I. duPont science teachers in conjunction with Project DELTA. [8, 10, 11]

ATTITUDES

A study shows improved attitudes toward science for students using the CMI system [15].

EMPLOYMENT

High school students are the instructors for the staff development program at Alexis I. High School.

REFERENCES

[8, 10, 11, 15]

Spectrum of Applications

Computer Science is a separate department with four courses (see Computer Science section).

MATHEMATICS

Applied Computations I, II, III. Remedial drill and practice.

8th Grade Math. Computing Literacy

SCIENCE

Introduction to Chemistry & Physics. Testing and management: In this course students proceed through the instructional materials at their own pace. The computer administers tests, grades the results and provides students with immediate feedback on their progress. The system provides mini-assignments to students who do not meet criteria for a particular objective. Tests are randomly generated and questions are not repeated for an individual. Computer generated reports give teachers a record of student progress [14].

BUSINESS AND VOCATIONAL EDUCATION

Model Office Simulation. APEX is a simulation of the office of the American Paper Exporters. Each student has a responsibility within the company eventually rotating with other students to get experience filling all the job positions.

ENGLISH

English I, II, Basic. Remedial drill and practice in reading and language arts.

GUIDANCE

GIS, a college and career information retrieval system.

HOME ECONOMICS

Foods and Nutrition. Metric recipe conversions.

SPECIAL EDUCATION

Remedial drill and practice in math, reading and language arts.

Computer Literacy

FOR: Decision-makers

BY: Computer Project Director

SINCE: 1976

PROGRAMS: Progress reports are given two times/year to the School Board.

Private meetings are held with the Superintendent.

All local decision-makers receive the computing newsletter.

FOR: All faculty

BY: Computer Project Director and Students

SINCE: 1977

PROGRAM: Demonstration of computer activities in the respective disciplines of the faculty.

Minimum of one-half hour "hands on" experience at the terminal.

IMPACT: All faculty have had some exposure to instructional computing.

FOR: 8th grade math students; interested 9-12 graders.

BY: Middle School Math Teachers; Computer Project Director.

SINCE: 1976

PROGRAM: Introductory Computer Knowledge is a 9-week, 1/4 credit course in the high school, and part of 8th grade math at the Middle School. Students use the computer 2 hours/week in addition to class meetings. Course goals are that each student will:

- understand the impact of electronic data processing on society
- develop a basic knowledge of computer system organization and concepts
- understand the human-computer interface in an interactive environment
- explore the various careers available in the data processing field
- describe the configuration, capabilities, and accessability of the school's computer system
- develop at least one computer application of personal benefit.

Students also learn fundamentals of BASIC programming.

COST:

$30/student	(Middle School)
$50/student	(High School)

(Costs include equipment, maintenance, staff, curriculum development, materials and supplies.)

85

Computer Science

FOR: Interested students, grades 9-12

BY: Computer Science Department
(Computer Project Director, and 3/4 time faculty member)

SINCE: 1976

PROGRAM

Introductory Computer Knowledge. Grades 9-12, Quarterly Elective—1/4 credit. The focus of this course is twofold: the student develops a basic knowledge of computer concepts, capabilities and limitations and, at the same time, the student learns about the impact of computers upon society and is introduced to the various career opportunities available as a result. Use of the school's computer system is an important part of this course.

Computer Languages and Programming. Grades 9-12, Semester Elective—1/2 credit. Prerequisite: Introductory Computer Knowledge or permission of the instructor. The student becomes skilled in programming in the BASIC computer language and is introduced to other high-level programming languages such as FORTRAN and COBOL. Operating system concepts also are studied, utilizing the school's computer system.

Computer Architecture. Grades 10-12, Semester Elective—1/2 credit. Prerequisite: Computer Languages and Programming and permission of the instructor. This course consists of an indepth study of the components of a total computer system—both hardware and software. The student learns to evaluate specifications for computer systems to determine their appropriateness in various businesses and industries. Computer networks are utilized for advanced programming applications. Systems programming and systems management are covered.

Independent Study in Computer Science. Grades 9-12, Semester Elective—1/2 credit. Prerequisite: permission of the instructor. The advanced student in computer science pursues topics of individual interest or assists in programming projects under the supervision of the director of computer science.

Students may also participate in operational aspects of the computer science program:

- as student applications and systems programmers
- as student computer facility managers
- as student assistants both in the computer science courses and in courses in other disciplines that utilize computers.

IMPACT

Two overall purposes of curriculum design:

- For the student who is terminating his education at the end of high school: a background in information processing that will facilitate the smooth transition from the formal education setting to a career that may have been greatly impacted by the computer.
- For the student who is continuing his education beyond high school: a solid groundwork in an increasingly critical tool in higher education.

COMPUTER-BASED LEARNING MATERIALS

Instructional applications developed by A.I. duPont are supplied to other institutions at no cost.

COMPUTER FACILITIES

Alexis I. duPont School District administers Project DIRECT, a state-wide system of computer-assisted instruction in mathematics, reading and language primarily for handicapped students. Participation includes all the State's public school districts and all State-operated residential children's institutions. Three computers and a state-wide multiplexor network are operated by Alexis I. duPont District for the State (see Figure 1).

EXPERTISE

Numerous articles and presentations are available on the CMI science system. [2, 7 through 15].

Compunotes, the monthly newsletter, is distributed throughout the District to all network users and State superintendents, as well as interested people all over the U.S. [1].

COMMUNITY SERVICES

Individualized continuing education classes in computer science are offered annually in the evening for adults and students.

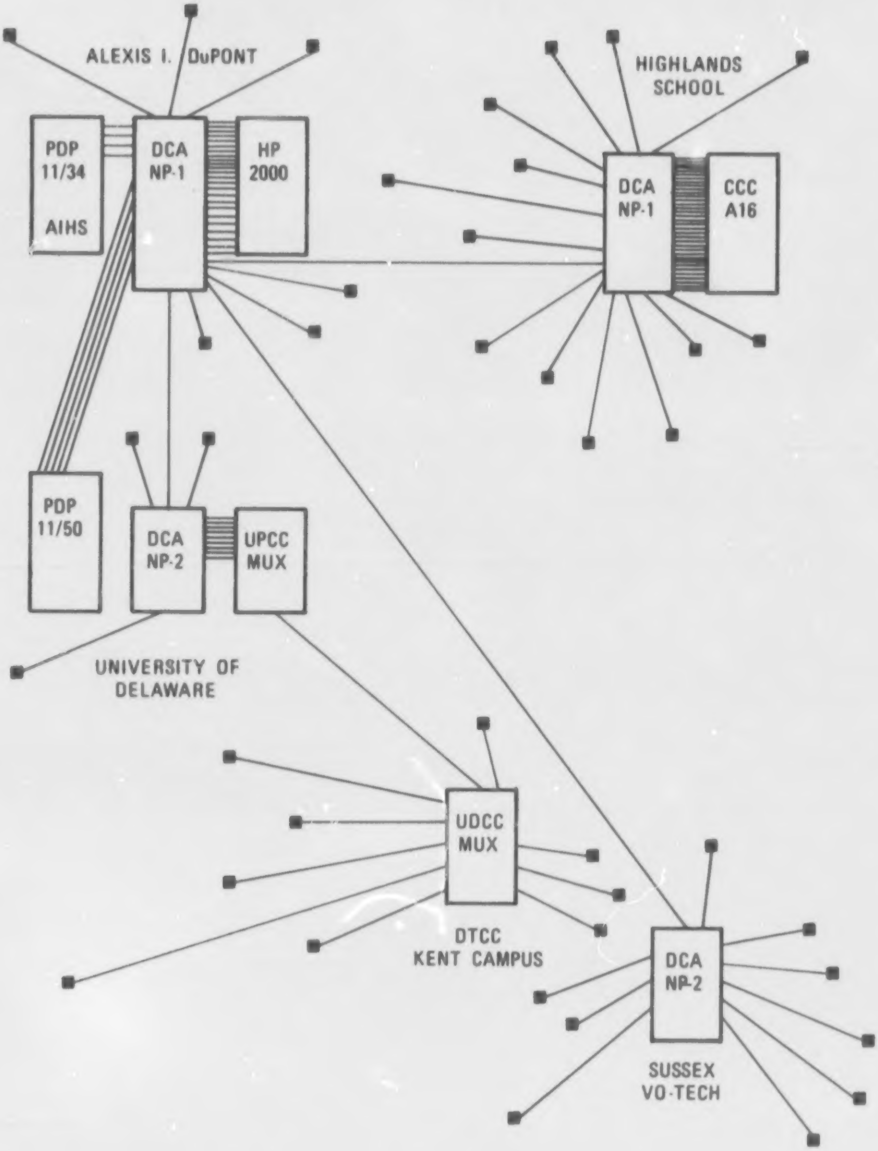

Figure 1. **Outreach: State Network**

Plans and Goals

ORGANIZATION

A.I. duPont has been merged with other districts in New Castle County. Since these districts have neither the computing curriculum nor facilities of duPont, it is necessary that the Computer Project "prove its worth" in order to survive the organizational change.

USE

The mission of the Computer Project is to encourage the use of computing throughout the high school programs. They believe that computing applications are useful and desirable in all disciplines.

Immediate plans include integrating computing into the social science and accounting courses.

The Alexis I District plans to expand the computing literacy curriculum and remedial applications to more of the students.

Programs for gifted students and for tutors in reading are being planned for elementary schools.

For college-bound students, mini-courses in a variety of computer languages are being planned.

Advanced computer training for all teachers in all disciplines is being planned.

EQUIPMENT

Color graphics and APL terminals are being acquired for use by advanced students.

Plans are being made to use microprocessors interfaced to the larger systems.

A machine-to-machine interface is being undertaken with Project DIRECT, a State network.

Lessons Learned

Carl Hauger, Computer Projects Director, has the following advice for those involved with instructional computing.

ORGANIZATION

Active support of the school board and top administration is a necessary prerequisite to a successful instructional computing program.

Having the computer facility as an independent entity (not associated with the Math or Science departments) provides for smoother integration of computing into all academic disciplines and seems to more easily attract the less accomplished (class-shy) student.

While terminals can be readily located in any classroom in the building, they have found that the computer classroom concept with centralized terminals is preferred by most teachers for reasons such as the numbers of terminals available, and computer staff supervision of students.

STAFF

More than one staff member should be actively involved in instructional computing to provide continuous coverage.

Let the students help. They invariably have more time than staff members. There are many interested students who make excellent applications programmers and system managers (where confidentiality issues permit).

Abnormally long school days are invariably necessary to produce the most beneficial results in terms of numbers of students served, cost effectiveness of equipment, etc.

USERS

Introduce the students to computing at as early an age as possible.

HARDWARE AND SOFTWARE

Select computer systems that have the maximum flexibility to grow in terms of both hardware and software. In the instructional environment, this is much more critical than in the business or administrative environment.

Other educational users are the best source of instructional software, particularly in light of limited educational budgets. The quantity, proximity, and variety of educational users with similar equipment should be paramount in the selection of a computer system.

Contacts

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Ruth Smith
High School Science Teacher

Bill Cole
High School Mathematics Teacher

Doris Collins
Middle School Mathematics Teacher

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HUNTINGTON BEACH UNION
HIGH SCHOOL DISTRICT
HUNTINGTON BEACH, CALIFORNIA

Huntington Beach has a policy of unlimited free access for instruction, modeled after a public library. This policy is financially feasible because of the District's arrangement for sharing computing facilities between administrative and instructional users.

SIZE

Public school district of 20,000 students, grades 9-12, in 6 comprehensive high schools and several continuing education centers; 800 faculty.

STUDENTS

The student population is 93% white, 1% black and 6% Mexican-American and Asian. 75% of the students attend at least one year of college. The majority of students are from upper middle-class families.

The average student score on State standardized tests is in the 75th percentile.

CURRENT ISSUES

Each school offers a comprehensive curriculum.

A major problem for the District is crowded schools. Consecutive bond issues to finance the construction of new schools have failed to pass.

Proposition 13 has caused a $6 million cut in the District's budget of $42 million. This decrease has not had an adverse effect on classroom computing.

The Past Ten Years

From an historical perspective, it was the influence of local colleges that motivated the staff in Huntington Beach Union High School District to become involved with instructional computing. The students, aware of the computing facilities available at the colleges, were anxious to use computers in their high school programs.

Huntington Beach's instructional computing program, known as HATS (Huntington Area Timeshare System), serves their own high schools as well as several elementary school districts. HATS is now the initial component of a twelve year computer curriculum culminating in the programs at either the nearby Coast Community College or the University of California, Irvine.

1968	Leased one terminal per school and bought computer time from a G.E. timesharing system ($8.00/hour). Initiated faculty training.
1969	Taught first Computer Science courses.
1970	Began leasing time from University of California, Irvine (UCI) for $2.50/hour.
1972	Used approximately 10 dial-in ports at UCI. Gave responsibility for all computing and data processing to the Division of Planning, Research and Evaluation. Recognized the need to replace administrative batch-only computer.
1973	Purchased IBM 370/135. Established policies for sharing the computer between administration and instruction (students on-line during the day; administrative batch processing nightly).
1974-75	Initiated program to employ students as aides for instructional computing. Had 20 dial-in ports at 5 schools.

1975-76	Made programs for administrators in the schools available on-line via classroom terminals. Expanded BASIC programming classes to include FORTRAN, APL, COBOL and Assembler. Had 32 lease-line ports available for HATS users.
1976-77	Established data processing intern position (2 alumni, 1/2 time) to oversee entire HATS program. Began to provide instructional computing services to 8 elementary schools. Had 48 ports available for HATS users.
1977-78	Added second CPU. Dedicated IBM 370/135 to HATS and 370/145 to administrative on-line users. Had 56 ports available for HATS users.
1978-79	Expanded computer program in one high school to 14 ports; school's computer center houses both programming and word-processing classes. Had 70 ports available for HATS users.

Organization and Management of Academic Computing

Administrative and academic computing are both under the auspices of the District's Division of Planning, Research, and Evaluation.

MANAGEMENT

Assistant Superintendent for Planning, Research and Evaluation, Glen Dysinger, is responsible for all computing activities.

The Huntington Beach Board of Trustees annually reviews and approves policies for computer sharing and budgeting.

STAFF

Two college interns, both Huntington Beach graduates, staff the District HATS Computer Center for academic computing.

Student aides manage the school Computer Centers.

Student Access to Computing

COMPUTERS:	IBM 370/135 and IBM 370/145
TERMINALS:	64 CRTs and TTYs
USERS:	Approximately 62 annual student users per terminal, assuming 64 terminals and 4000 annual users. Figure 1 shows the average user load on HATS.
WHERE:	Two locations in each of the 6 high schools. One location in a continuing education center.
HOW:	Established "Computer Sharing Guidelines" (see Figure 2) which describes the priorities for computer use. This policy provides unlimited free access for instructional purposes, modeled after a public library. Any student who requests an account number may get one from a teacher. Any student may go to a Career Center and use CVIS, a vocational and college information retrieval system. (An account number is not needed.) Extensive system documentation is available both as reports and on-line. These data aid student and faculty as well as administrators and other decision-makers. The timesharing system (HATS) is available 10 hours each day.

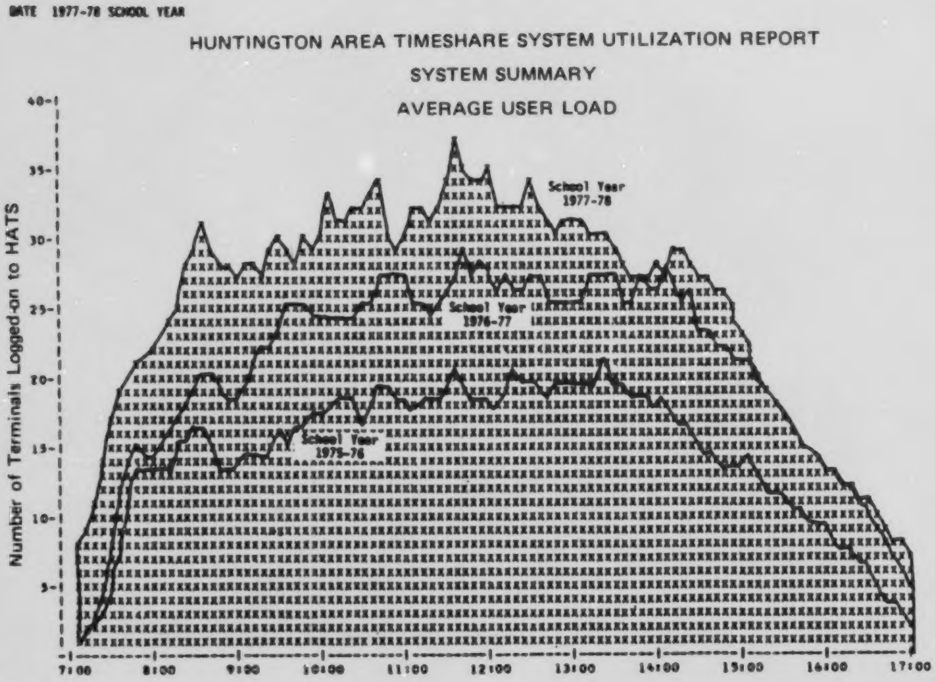
DATE 1977-78 SCHOOL YEAR
HUNTINGTON AREA TIMESHARE SYSTEM UTILIZATION REPORT
SYSTEM SUMMARY
AVERAGE USER LOAD
Number of Terminals Logged-on to HATS
40
35
30
25
20
15
10
5
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
School Year 1977-78
School Year 1976-77
School Year 1975-76

Figure 1

GUIDE2

HUNTINGTON BEACH UNION HIGH SCHOOL DISTRICT

Computer Sharing Guidelines

1. During daylight shift (0700 - 1700), 370/135 HATS computer access by all students and classroom teachers shall receive the highest priority. HATS shall also be made available for Adult School's utilization from 1700 to 2200 weekdays and 0800 to 1500 Saturdays.
2. All HBUHSD and on-line administrative applications shall have top priority on the 370/145 CICS System from 0700 to 2200.
3. The morning shift (2200 - 0700) and weekends shall be available daily for Sharing School District batch applications.
4. New computer applications will be developed according to priorities established by a committee to be designated by the Superintendent.
5. Computer sharing charges will reflect the actual production costs of each service.
6. Income from sharing contracts shall provide adequate equipment to preclude a reduction of HBUHSD classroom, school or division computer service while Sharing Districts are on-line. To assure fiscal solvency, a deposit account shall be maintained to accrue sharing income prior to equipment lease or purchase.
7. Sharing School Districts shall be entitled to one HATS (Huntington Area Timeshare System) port for the first $20,000/year of sharing and one additional port per $10,000/year thereafter. Alternatively a Sharing District may pay $500/month per port. All terminal and telephone line costs are to be borne by the Sharing District.
8. Computer resource sharing contracts shall be ratified by the Boards of participating Districts.
9. Expanded sharing income shall be sought while increasing HBUHSD services so that annually more personnel and equipment costs may be moved from the regular budget to the Sharing Income account.
10. These guidelines will be constantly reviewed as to their equity to all parties and be revised as needed to reflect prudent Computer access & utilization.

Approved by Board of Trustees	July 23, 1974
Reapproved by Trustees as modified	February 25, 1975
" " " " "	June 22, 1976
" " " " "	March 22, 1977
" " " " "	July 11, 1978

*END

*GO

Figure 2

Costs and Budgeting

FUNDING

The District has an established policy for financially supporting academic computing.

All system costs are borne by administrative applications and revenue from outside districts. Income from other districts has increased annually over the last 4 years. This income pays for staffing and equipment for academic computing.

The funding for computing is 55% State, 45% local.

Total cost of computing is maintained at 1.2% of entire District budget.

BUDGET HISTORY

Total computing budget for the District, for 1978-79, including administrative applications, is $424,772.

Estimated proportion of total expenditures attributed to instruction is as follows:

1969-70	$ 5,000
1973-74	$ 20,000
1976-77	$175,000
1977-78	$175,000
1978-79	$ 25,000*

Cost figures include equipment, maintenance, software leases, and student staff for instructional computing only.

***NOTE: After passage of Proposition 13, in June 1978, Huntington Beach paid off both their administrative and instructional computers with school reserves that would have otherwise reverted to the State. As a result of Proposition 13, computing is actually on a stronger financial base. The 1978-79 budget needs to include only student staff, maintenance, communications, and software leases.**

INSTITUTION PRODUCTIVITY

Additional cost savings have been realized in the District by using HATS for word and text processing instruction and document production.

Student Accomplishments

Student accomplishments are in the categories:

- projects
- awards
- employment

PROJECTS

Students wrote a series of on-line programs to carry all scoring and results of a county-wide academic decathalon hosted by a Huntington Beach high school.

A student authored a program to survey all County school professional salaries on the HATS computer.

AWARDS

A 7th grade student won the 1977 County Science Fair with a computer project.

EMPLOYMENT

A student is working for Radio Shack developing software for their microcomputer, TRS-80.

Present and former Huntington Beach students are the staff for instructional computing. Student aides fill a series of positions. They include:

- Elementary and High School Cross-Age Tutor
- Exploratory Work Experience
- Employed Work Experience
- College Aide (Alumni only)
- EDP Intern

These aides have:

- maintained and modified the instructional system
- created sophisticated programs for teachers and other students
- provided tutoring for less knowledgeable students and teachers.

Spectrum of Applications

MATHEMATICS

Computer Programming. Teach ASSEMBLER programming.

Computer Programming. Teach BASIC and VSBASIC programming.

General Math. Use a math program (MATHPAK) for drill and practice (limited use).

Statistics. Use a statistics package (STATPAK) for derivation of Chi-Squares, etc.

SCIENCE

APL. Teach APL programming.

Individual Projects. Students access ERIC (DIALOG) for computer searches of educational research literature.

Life/Physical Sciences. Huntington II simulations.

SOCIAL STUDIES

U.S. Government. Huntington II simulations.

BUSINESS

Accounting. Students use of integrated system of accounting programs, authored by Dr. Wilbur Pillsbury [3].

COBOL. Teach COBOL programming for business applications.

WORD PROCESSING. Emulate IBM Mag II system and video display equipment via SCRIPT, a computerized word processing system.

ENGLISH

Communication Skills. Spelling tutorial (drill and practice).

College Composition. Use ERIC (DIALOG) for computer searches.

Speech. Tournament scheduling.

GUIDANCE

CVIS, a career, education, military, and scholarship inquiry system.

PHYSICAL EDUCATION

Scouting analysis system for football.

Competency tests and storage system.

MEDIA SERVICES

On-line media materials ordering and distribution.

LIBRARY

Overdue book system (student-developed program).

WORK EXPERIENCE

CVIS career exploration. School and District exploratory and employment positions as aides in computer centers.

Computer Literacy

Computer literacy programs exist for four discrete groups. The goal is to constantly broaden the scope and depth of literacy for each group.

FOR: Board of Trustees

BY: Division of Planning, Research and Evaluation

SINCE: 1974

PROGRAM: Annual report to the Board describing the rationale behind and use of the computer in instructional process.

Annual adoption by the Board of computer use guidelines and policies.

Dialogue with the Board by students, teachers and administrators to insure their understanding of the issues when approving sharing guidelines and expenditures.

FOR: Administrators

BY: Division of Planning, Research and Evaluation

SINCE: 1974

PROGRAM: Annual 3-hour meeting to help administrators understand the need for instructional computing and to plan next year's goals, for both academic and administrative computing.

IMPACT: At Huntington Beach, computer literacy for administrators is particularly important since higher priority is given to classroom use of the computer than management needs. (After 4 years of classroom direct computer access, administrative applications have gone on-line.)

FOR: Faculty and school staff

BY: HATS staff

SINCE: 1968

PROGRAM: Each principal is held accountable to maintain at least one teacher knowledgeable about computing.

HATS provides short system orientation workshops for these teachers. Self-help manuals are also available.

Tutorial programs on HATS to teach BASIC and APL.

Programming classes are offered at local colleges. Teachers receive credit toward salary advances by completing these courses.

IMPACT: Approximately 25% of faculty have used HATS. Since all on-site equipment (terminals and modems) are purchased or leased from individual school budgets, it is imperative to have a knowledgeable teaching staff willing to defend ongoing expenses.

* * *

FOR: Interested students

BY: Teachers and other students

SINCE: 1974

PROGRAM: Use of CVIS (guidance and career information system) by students who have no experience with computing.

Within the free access environment, students may acquire an account from a teacher and learn to use the system from other students. Inexperienced users often access CAI tutorials and the Huntington II simulations.

Formal computer science courses and/or units in programming in all schools.

IMPACT: Half of all Huntington Beach students have used the HATS computer before graduation.

Computer Science

FOR: Interested students, grades 9-12. 1200 students/year.

BY: Teachers in Math, Business and Science Departments.

SINCE: 1968

PROGRAM: The approach toward computer science follows the philosophy of the District, that a decentralized curriculum is more effective than centralized development. Diverse software and applications programs are offered by HATS, so that teachers and students in the different schools can develop the best academic computing program for their needs.

A four-year program of instruction in Computer Science is offered.

Each high school has a different program. For example, whereas one school may emphasize data processing, another would concentrate on computer math.

One-semester courses in five programming languages (BASIC, COBOL, ASSEMBLER, FORTRAN, APL) are offered.

Course titles include:

- COBOL/FORTRAN/APL
- Computer Science
- Data Processing
- Computer Math
- Advanced Computer Math
- Business Office

IMPACT: Enrollment in computer science is exceeding the capacity of the courses at many schools.

Outreach

COMPUTER FACILITIES

HATS is used by 5 feeder elementary districts. Free instructional computing is provided with $20,000 expenditure for administrative computing services by each district (see Guidelines, Figure 2).

Distant districts are issued demonstration accounts for browsing through the system's programs.

EXPERTISE

Workshops are provided for elementary school teachers.

Huntington Beach participates with 8 other secondary districts in CROP, a regional occupational district that enables students to take training programs not available in each individual district. The group is sponsoring the expansion of word processing training in the area.

Numerous visitors are provided demonstration workshops.

Huntington Beach publishes a newsletter several times each year.

Lessons Learned

Mr. Glen Dysinger discusses the experience of Huntington Beach.

ORGANIZATION

HATS has been modeled after a free public library in that many diverse applications are offered along with multiple compilers, with no limit placed on access or storage. With minimal workshop training, teachers and students quickly developed at each site their own academic computing programs. At Huntington Beach they feel this is proof that decentralized curriculum development is far more effective than centrally developed courses.

HATS has found for four years that a timeshare system can grow each year without adding staff to the two half-time computer interns who operate and maintain the system.

A beneficial side-effect of having student aides staff the computer center is the avoidance of the computer guerilla warfare (e.g. students trying to outwit the computer to make it unavailable for other users) which has occurred in many other high school computer systems.

USE

The myth that high school and elementary students should use only BASIC on a minicomputer to be cost/effective for school budgets can no longer be justified, particularly with the potential of sharing facilities with administration. Dysinger believes that the wider experience (i.e., seven language compilers) available to their students makes it more feasible for students to enter computer-related careers.

Guidance applications (CVIS) and multi-compiler programming can exist on the same system with CAI and simulations. However, they have found in Huntington Beach that student use of the computer for programming will gradually preempt the other applications unless restricted by staff intervention.

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First graders began using HATS two years ago. The activities of these children indicate that drill and practice is not the only feasible computer application in the primary grades. Many children can and want to learn computer programming. Others are able to learn concepts in science and social science by using simulations.

Once classroom computing is established, a District must anticipate expansion. Providing for the future income necessary to achieve growth must be an integral part of the program.

Plans and Goals

USE

A goal of HATS is to expand beyond programming into additional instruction on word processing. The business departments use HATS to simulate a small business computer environment, as well as emulate several types of word processing shops. Last year, 16 students (with 5 terminals) took the first word processing course. This year a major problem, the reluctance of the mathematics and business departments to pool their separate terminals, was surmounted. 82 word processing and 34 data entry students are now taking courses using fourteen terminals. At Huntington Beach they foresee continued growth in both the use of, and instruction in, word text processing.

Word processing and data entry classes will expand to use 15% of the machine's total load.

SOFTWARE

Plans call for adding more compilers, including PL/1 and Algol. They also hope to install a new version of their timesharing system, MUSIC IV.

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Debbie Wilson
Ocean View High School

Lee Votchko
Circle View Elementary School

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GEORGE WASHINGTON HIGH SCHOOL
DENVER, COLORADO

George Washington High School Computer Mathematics curriculum provides students an opportunity to do in-depth projects. These projects benefit not only the student, but also the local schools and community.

Profile

SIZE

2000 students, grades 10-12; 111 faculty.

One of 9 high schools in the Denver Public School System.

STUDENTS

Students are 51% white, 43% black, 3% Hispanic, 3% other.

The majority of black students are bused from another area of Denver.

48% of the students apply to college.

CURRENT ISSUES

George Washington has been adjusting its counseling services and curriculum to meet the occupational needs of the minority students.

The George Washington faculty is striving to dispel the notion that a student cannot obtain a quality education in a city school.

Similar to many other large city school systems, the Denver Public Schools are faced with budget cuts, busing, declining enrollments and the loss of upper middle-class students to suburban schools.

The Past Sixteen Years

In 1960, the interest in computers shown by members of the Math Club and their sponsor, Dr. Hoffman, was the significant event that encouraged growth of instructional computing at George Washington High School.

1960-62	Math Club inquired about computing. Control Data Corporation gave a non-credit class in FORTRAN to gifted math students.
1962-66	University of Denver gave high school students free instruction in ALGOL programming.
1966	Denver's Opportunity School rebuilt donated computers (IBM 1440). GW students learned about computing in FORTRAN after school at the Opportunity School.
1967	Computer Math became a credit course.
1968	Teacher training in computing first offered by Denver Public Schools. School system wrote their own FORTRAN and BASIC textbooks for a rented IBM 1130. Dr. Hoffman was a member of this development team.
1970	Denver Public Schools acquired Univac 1106 for both administrative and instructional applications. Language availability included ALGOL, FORTRAN, BASIC and COBOL. University of Denver received National Science Foundation grant for curriculum development. Three George Washington teachers were released half-time to write computer units under this grant.
1971	George Washington won the first of three Awards for Excellence from Denver Public Schools. These cash grants helped the computer program to expand.

1972	George Washington hired a Math Lab Supervisor from Award for Excellence funds.
1973	U.S. Department of Transportation recognized student-written carpool program. Dr. Hoffman was released from teaching to aid dissemination and implementation of the program within the Denver metropolitan community.
1974	Computer Math units, involving computer applications from Algebra through Calculus, were published through the University of Denver.

Organization and Management of Academic Computing

Administrative and instructional computing share the same computer at a central location in the Denver Public Schools.

MANAGEMENT

Administrative computing and instructional use of the large scale computer is controlled by the Executive Director of Education and Management Information Services.

Instructional computing is under the auspices of the Supervisor of Mathematics Education Curriculum Development.

Computer math teachers in each school plan their courses and manage the use of computing facilities by faculty and students from other departments.

STAFF

Dr. Hoffman, Computer Math Teacher, is responsible for Computer Math courses at George Washington.

George Washington's Math Lab, including most of the computer equipment and resources, is managed by a paraprofessional aide.

COOPERATIVE ARRANGEMENTS

George Washington coordinates with the University of Denver's Math Laboratory for development and publication of curricular materials.

Administrators and instructional staff at George Washington economize and cooperate by sharing equipment (terminals and keypunch) and personnel (messenger for batch computing).

Student Access to Computing

COMPUTERS

Access to Denver Public School's Univac 1130

6 programmable calculators:

- 2 Monroe 1880
- Hewlett Packard 25
- Hewlett Packard 65
- Wang 60
- Texas Instruments SR-52

TERMINALS

6 TTY[1]
1 plotter[2]
2 keypunches[2]

USERS

Five classes of computer math and consumer math students, as well as other interested students.

WHERE

Most students work in the specially designed Math Lab. The lab is open 8 hours each day.

HOW

Any student or teacher who requests it can get an account number. A Math Lab Supervisor is available to aid students and faculty.

[1] Including one shared with the administration.
[2] For Monroe 1880.

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Costs and Budgeting

FUNDING

Computing is funded totally from local District dollars. Approximately 30% of the total computing budget is for instruction.

BUDGET HISTORY

Instructional computing by calendar year has cost:

Denver Public Schools	
1970	$184,000
1971	$184,000
1972	$202,000
1973	$202,000
1974	$232,000
1975	$232,000
1976	$270,921
1977	$356,120
1978	$333,559

George Washington High School	
1975	$35,173
1976	$37,539
1977	$39,573
1978	$35,498

Figures include equipment, maintenance, and technical system support staff for instructional computing only.

With the exception of Denver's Opportunity School, a vocational high school, George Washington, uses a greater proportion of Denvers instructional computing budget than any of the other eight high schools.

George Washington's in-school budget has allowed the computer math program budget to grow beyond the budget allocated to it by the school system (e.g., extra materials and books purchased for additional computer math students; a salary for a Math Lab Supervisor; modification to the Math Lab).

Student Accomplishments

Student accomplishments are in the categories of:

- projects
- awards
- employment

PROJECTS

A second-year computer math student at George Washington selects an area of interest and undertakes an independent project. Many of these projects have provided computer software for other courses at George Washington, as well as various community organizations.

In 1973-74, four students designed a carpooling program. The carpooling program examines a digitized map of an area, calculating concentric circles from 1/2 to 5 miles in diameter around where a person lives and works. The output of the program is a list of up to ten people with whom the person might form a carpool. The program also considers in-route carpools and bus or van carpooling. The program was so sophisticated that the U.S. Department of Transportation invited representatives from George Washington High School to Washington, D.C., to brief them on the computer program. Subsequent to this visit, the Department of Transportation published a document stating that this program was one of the best portable carpool programs available in the United States. The entire computer class briefed the community. The school then organized and developed the initial carpooling system for the five counties comprising metropolitan Denver. The students and their instructor, Dr. Hoffman (who was relieved of his teaching duties to pursue this project), aided over 50 corporations outside the area. They designed the carpool map and the computer printout used by the Denver Regional Council of Governments. They testified before legislative committees and raised money from the joint Budget Committee for carpooling in their community. Their efforts brought them commendations from the City Council of Denver, the Region 8 EPA, and the President of the U.S. One of the students was hired by the City and County of Denver to establish carpooling for city employees.

In 1977, a student designed a regression model of sales tax revenues from 34 basic industries in the city of Denver to help the city and county predict future revenues from tax receipts. The student was subsequently hired by the Denver Budget Department for summer work.

Students wrote a program at the request of the Rabbinic Council of Denver to help match single adults in the local area, and have completed a computerized survey on the living habits of the retired Jewish community.

Students wrote a Gran Prix ranking system now used by the Colorado Tennis Association; they are now writing bookkeeping programs and a program for random tournament draws for this organization.

Advanced computer students have written curricula for consumer mathematics including units that teach budget considerations, inflationary spirals, simple certificates of deposits, population growth, pollution measurements and various saving plans (e.g., [4, 7.])

Current student projects include a poll analysis for the Governor's re-election campaign for prediction purposes.

AWARDS

Science Fair winners in 1962.

Prizes in programming contests in 1963 and 1964.

First student-presented papers at a National Council of Teachers of Mathematics Sectional Convention in 1965.

EMPLOYMENT

Many students have entered computer-related careers including:

- Computer designers for NASA, Texas Instruments
- Programmers for NASA, State Departments, Corporations
- Editor, *People's Computer*
- City Planner
- Consultants for Monroe and Wang Calculators
- Computer science teachers

REFERENCES

[2, 3, 4, 5, 6, 7, 9, 10, 12.]

Spectrum of Applications

Programs for use in various disciplines were written by second-year Computer Math students.

About 12% of the students use the computer each year. Applications include the following:

MATHEMATICS

Consumer Math units; probability experiments; graphing. The computer science program is also administered by the Mathematics Department.

SCIENCE

Physics experiments; curve-fitting for Chemistry; study of heart rates in Biology; rainfall, temperature predictions in Ecology. Modeling of energy use in students' homes. Development of an "ideal" computer-managed home in terms of energy.

SOCIAL SCIENCES

Sociology, questionnaire analysis; Psychology, biorhythms.

ENGLISH

Analysis of similes in Shakespearean plays.

Haiku poetry program for advanced placement English classes.

ART

Calculation of the kiln temperatures that are required for various ceramic glazes. A new program is being developed to determine the most cost-effective chemicals to use as substitutes in the absence of desired glazes.

MUSIC

Development of music with chords.

EXTRACURRICULAR ACTIVITIES

All football statistics are calculated by student-written computer programs. Golf handicaps for students are determined via computer.

Computer Literacy

There is no formal computer literacy program at George Washington; however Consumer Math Students as well as students in some other disciplines are exposed to computing during their courses.

Computer Science

FOR: 50-80 students each semester, grades 9-12.[1]

BY: 1-2 faculty members from the Math Department

SINCE: 1960, informally; 1967, formally.

PROGRAM:

Two-year Computer Mathematics Program.

The first-semester curriculum includes writing four math programs: systems of linear equations, quadratic equations, prime numbers, and Fibonacci sequences. These assignments are programmed in ALGOL, FORTRAN and BASIC and on the programmable calculators. Also included is a large program involving sorting and measures of central tendency. The second semester includes writing programs such as frequency distributions, analysis of the roots of a polynomial and plotting the curve (on a plotter), a Gaussian analysis of a system of five linear equations with five unknowns, and simple statistics with the plotting of regression lines.

Second semester students read William Dorn's text, *Finite Mathematics with Computing*, and use his techniques to model a problem in epidemics, economics or the population explosion. They also plot a random walk, write the least distance between nodes program and a spanning tree program, and solve a linear programming problem.

Third and fourth semester students find an area of interest that lends itself to computer application for an independent project. They also may choose from units selected from National Science Foundation monographs, National Council of Teachers of Mathematics journal articles, and other articles (many on the energy crisis).

[1] Ninth graders do not attend George Washington. Feeder junior high schools can make informal arrangements for their better students to come to George Washington to take these courses.

Outreach

COMPUTER-BASED LEARNING MATERIALS

Computer Math units developed at George Washington were published by the University of Denver Mathematics Laboratory with support from the National Science Foundation [4].

Computer-oriented Consumer Math units developed at George Washington are used throughout the Denver metropolitan area.

COMPUTER FACILITIES

The Math Lab at George Washington is available for use by local junior high schools.

EXPERTISE

Numerous articles and presentations have been given by students and staff. They ran booths at the 1976 National Council of Teachers of Mathematics meeting to present their curriculum.

Visitors are received regularly.

Dr. Thomas Dwyer made a movie on "solo computing" at George Washington for the National Science Foundation.

The National Council on Quality Education made a movie for its members highlighting George Washington's Math Lab.

Dr. Hoffman provides advice to other educators on the purchase of programmable calculators [6, 9].

COMMUNITY SERVICES

Student-written programs have benefited the community (see Student Accomplishments).

ADMINISTRATIVE SUPPORT

Dr. Hoffman's advice to those with a commitment to academic computing is to persevere at higher and higher levels of the administration. One must persist until the backing of principals, supervisors and superintendents is achieved.

Certain techniques for pleading the case of instructional computing, such as picketing, media attention, and competing for and winning awards can all be effective.

Plans and Goals

EQUIPMENT

Denver Public Schools is doing a pilot study on using microcomputers in the schools. They feel one benefit of using microcomputers would be to lessen the security problems on the central system, and lower the costs.

Dependent on the outcome of the study, they plan to either upgrade the central computer or provide microcomputers to the schools. They are currently tending to lean toward purchasing microcomputers to replace schools' time-sharing terminals.

George Washington hopes to increase the number of terminals and/or microcomputers in the Math Lab, including additional graphics equipment.

USE

At George Washington the staff is striving to maintain a viable curriculum that reflects issues in contemporary society. A review of techniques found in new textbooks provides a basis for curriculum revisions.

Contacts

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LINCOLN HIGH SCHOOL
INDEPENDENT SCHOOL
DISTRICT #271
BLOOMINGTON, MINNESOTA

Lincoln High School is a member of TIES (Total Information Educational Systems), a network that supports both administrative and instructional computing needs of schools throughout the State. At Lincoln, instructional computing is administered through the Science Division.

Profile

SIZE

Lincoln High School has 1800 students, grades 9-12; 85 faculty.

District #271 is a suburban district with 3 high schools, all offering a complete program of general education.

STUDENTS

Students are primarily from upper middle-class families; less than 1% minority enrollment. 60% of the students attend college.

CURRENT ISSUES

District enrollments are steadily declining; elementary schools are closing.

The Past Thirteen Years

Academic computing at Lincoln began in 1965 when the mathematics department acquired two terminals to use for teaching computer math and programming. Since the formation of the TIES network in 1967, computing applications at Lincoln have steadily increased. Facilities and support provided by TIES have been a key factor in the increase in instructional computing.

1965	Lincoln leased computer time from a commercial time-sharing service.
1966	Educational Research and Development Council of the Twin Cities Metropolitan Area conducted feasibility study for TIES.
1967	TIES formed; 19 school districts jointly owned TIES as members of a Joint Board. Lincoln math department used TIES system for computer math and programming.
1970	TIES offered teacher in-service. Science department faculty attended in-service and undertook the administration of academic computing at Lincoln.
1971	Science faculty members developed Computer Technology Curriculum.
1972	Lincoln acquired 2 additional terminals.
1973	TIES offered an in-service course in COBOL programming at Lincoln for the business department staff. Business class use of computer activities initiated. TIES offered an in-service course on foreign language applications at Lincoln. The foreign language department staff initiated use of computer activities for their classes.
1976	Lincoln acquired video display terminal.

1977 Lincoln acquired 2 high-speed hardcopy terminals.

Career Center expanded and one terminal was assigned there for guidance applications.

TIES had 56 member school districts with 280,000 students. 50,000 employees, and 300 schools.

1978 Project Success, a program for learning disabled students, initiated the use of computer centered activities.

Lincoln acquired the use of a Chatsworth Card Reader; Lincoln initiated activities involving student marked cards in both Computer Technology Courses and in science applications.

Lincoln initiated test grading and analysis using student marked test cards and the card reader.

Organization and Management of Academic Computing

Lincoln is a member of TIES (Total Information Educational Systems) a regional network that supports both administrative and instructional computing. The TIES system covers one of seven elementary, secondary, vocational data-processing regions in Minnesota, the activities of which are coordinated by MECC (Minnesota Educational Computing Consortium). MECC is the statewide educational computing system that has jurisdiction over all such operations in the State.

STAFF

Each member district of TIES has an Educational Information Systems (EIS) Coordinator, responsible for liaison with TIES and coordination of all computing activities in the district. Dr. Orville Ruud, Bloomington's Director of Data Processing, fills this position for District #271.

Each TIES school with a terminal has a Terminal Supervisor to coordinate instructional computing activities within the school, usually including teacher assistance and scheduling terminal usage.

Instructional computing at Lincoln is managed through the Science Division. Mr. James Burke is the leader of the Division, and Terminal Supervisor.

SUPPORT

Support for academic computing (e.g., computer operations, maintenance, programming, advice, training, documentation) is provided by TIES personnel.

Student Access to Computing

COMPUTERS

Access to HP-2000 at TIES.

Access to CDC Cyber 73 at MECC (Minnesota Educational Computing Consortium).

TERMINALS

7 terminals including:
  2 DECwriters
  1 Teleray CRT
  4 Teletypes
1 card reader
1 plotter on periodic loan from TIES

USERS

One-third to one-half of the Lincoln students interact with the computer each year.

125 annual student users for each terminal, assuming 7 terminals for 875 annual student users.

WHERE

Terminals are in 4 locations:

- Open Science Lab
- Career Center
- Math Department
- Project Success area

HOW

Account numbers are assigned to all Computer Technology students.

Other students use faculty accounts.

Students have access to terminals 8 hours each day.

Costs and Budgeting

FUNDING

The District pays $10.25 per student per year to TIES for all administrative and instructional computing services. $2.00 per year of this figure is attributable to instructional computing.

Computing is a line item in the regular District instructional budget.

BUDGET HISTORY

1967-68	$ 350
1969-70	$ 500
1973-74	$1700
1976-77	$3500

These costs include only terminals and maintenance for instructional computing at Lincoln. Computer time and in-service training is provided through TIES.

Student Accomplishments

Employment is the focus of student accomplishments at Lincoln.

EMPLOYMENT

Computer Technology students have been employed in computer-related jobs during the summers with local business and industry or working with elementary students on computer activities.

A graduate follow-up study is in progress to trace the results of secondary school computer experiences.

Institution Accomplishments

STUDENT ENROLLMENT

Student enrollments in science courses, while decreasing nationally and at other high schools in the District, have increased yearly at Lincoln.

Example:	Chemistry enrollments
1975	150
1976	180
1977	205 (over 40% of the junior class)

Approximately 60 students/quarter enroll in Computer Technology courses in contrast to the previous enrollment of 15 students/quarter in computer math (since discontinued).

COST AVOIDANCE

Computer simulations used by the science instructors are alternatives for experiments that would normally be dangerous, difficult or prohibitively expensive. An example is a simulation of an acid-base laboratory titration used as an introduction to the laboratory process.

STUDENT EFFICIENCY

Data reduction programs to analyze students' science laboratory results have been found to be effective teaching aids. These programs relieve the tedium of repetitive computation that formerly might overshadow the development or demonstration of a major point.

The availability of computer facilities and learning materials provides an effective set of alternative learning activities for learning-disabled students at Lincoln. The staff believes student motivation has increased from using the simulation, drill and practice, and gaming activities.

Spectrum of Applications

50% of departments use computer facilities; 25% of staff are currently involved with computer activities. 34-50% of students each year exposed to computers.

MATHEMATICS

Drill and practice used for remedial level courses.

SCIENCE

Heaviest use of computing by the Science Division. Chemistry and physics activities include simulations, data analysis programs for laboratory support, tutorials to develop chemistry concepts, and games.

SOCIAL STUDIES

Political Science: Election simulation
Economics: Management simulation

GUIDANCE

Career information available via GIS (Guidance Information System) and MOIS (Minnesota Occupational Information System).

SPECIAL EDUCATION

Learning-disabled students use computer drills in math and science.

Other departments using computing applications include:

- Foreign Language (vocabulary drills)
- Business (introduction to data processing)
- Athletic
- Industrial Arts

Computer Literacy

FOR: 180 students each year of varying ability, all grades.

BY: Designed, developed and taught by faculty in the Science Division

SINCE: 1970

PROGRAM

Computer Technology I, II and III, a three-quarter course sequence.

Self-paced. All three sections meet simultaneously in the open science area.

Student activities are built around a series of objectively defined tasks requiring interaction with the computer at a terminal and producing a printout as a result for instructor evaluation. Provision is made for an incoming student with prior computer experience and programming skills to demonstrate these capabilities and enter the class sequence with advanced standing.

This program allows the students, through a sequence of self-directing hands-on computer activities completed at their own pace, to develop programming skills (in BASIC only at present) and a direct knowledge of computer operation. As programming skills grow, the second and third quarters of the sequence involve some selected activities introducing applications of these techniques to specific disciplines. Additionally, course design allows the instructor to develop, in depth, the supplementary topics concerned with computer impact in our society and the career implications of computer technology.

REFERENCES

Appendix I contains samples of the student activity sheets, which form the core of the curriculum by providing students with their individual assignments.

Plans and Goals

EQUIPMENT

In the fall of 1976, TIES established a task force to develop a long-range plan delineating TIES developmental, operational and delivery capabilities over the next 5 years. The task force has subcommittees on hardware, system software and applications software. This committee is studying several options. A major problem is that the increasing number of instructional users has saturated the available ports. The terminal-to-port ratio has increased beyond their ideal state of 2.5 terminals for every port. Several options are being considered. All involve a gradual phase-out of the Hewlett-Packard systems on site and a long-term reliance on the MECC Cyber 73 for time-sharing services. Schools will use microcomputers to fill additional needs not covered by time-sharing services. The current focus of the microcomputer activity will be on the Apple II, the computer that will be acquired by the schools following the award of a statewide bid in the fall of 1978 [2].

USE

Lincoln has recently acquired a card reader, and the staff is planning the most effective ways to use it. For example, one potential application would be a test-scoring system for the entire building. The Lincoln students currently do all their computing in BASIC. Mr. Burke believes that the students, particularly those continuing their studies in computer science, would benefit from exposure to a variety of computing languages. This multi-language capability will be available by using the newly acquired card reader.

In 1977, Project Success students used the Computer Curriculum Corporation's drill-and-practice (language arts and math) programs during a six week demonstration.

Although the cost of continuing to use this package was prohibitive, with respect to the project budget, the Special Education Department will expand the use of computing activities with these students in the fall of 1978.

Lessons Learned

USE

At Lincoln the computer is used throughout the school program. The Science Division personnel found that it was difficult to convince naive teachers that it was not necessary to learn about computers and programming in order to use existing instructional package.

The most common excuse for ignoring the computer-based materials is that using these programs would take too much time and it would not be possible to complete the text. They describe the "activity oriented" teacher as the one most likely to become involved with computing. Mr. Burke states:

> **"Even with direct in-service support from the TIES consortium and a general willingness by many staff members to operate an activity centered educational program, there is no magic method to involve reluctant teachers. A measure of our effectiveness is the rather widespread use of computer activities across a variety of disciplines as opposed to the somewhat limited number of faculty members involved in actual usage. Progress is slow, but persistence pays off."**

Another observation of the Lincoln staff has been the enthusiastic response of the students, to learning via computer. They believe this increased motivation has carried over into other classroom activities. Even more interesting is their belief that the activities traditionally regarded as boring (e.g., learning the symbols for the elements in chemistry class) are "fun" for the students when they are able to do them by interacting with the computer.

Contacts

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References

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APPENDIX I

Sample Computing Activities

ACCESS

PERFORMANCE OBJECTIVE:

The student will be able to access the Time-Sharing system.

ACTIVITY

The procedure which is briefly described here will be fully demonstrated in class.

I. Coupler Switches
   A. ON-OFF : ON
   B. DIRECT-ACST : ACST
   HALF-FULL : FULL

II. Terminal Switch
   LINE-OFF-LOCAL : LINE

III. Phone
   A. DIAL 636- ________
   B. Put the phone in the coupler with the cord end in the right position.

IV. Log-in Routine
   A. Type any number and the (RETURN) key.
   B. Type or tape the log-in code, ID, and (RETURN) key.

PERFORMANCE OBJECTIVE:

The student will be able to design a program which uses READ and DATA statements to input both prior to and during a loop.

CHECK BOX

COMMENT: The previous READ. . . . DATA exercise was slightly limited. It is not unusual for the values of more than one variable to be listed in the DATA statemtnt. Even the number of loops to be executed can be included in the DATA statement.

EXAMPLE: Your previous program on areas of circles might have looked like this if the DATA statement contained the number of radii:

```
10 PRINT"RADIUS","AREA"
20 READ N
30 FOR J=1 TO N
40 READ R
50 A=3.14*R↑2
60 PRINT R,A
70 NEXT J
80 DATA 3,2,3,8
90 END
```

INSTRUCTIONS:

We'll call this exercise "CHECKBOOK". Devise a program that reads the initial balance, the number of checks, and the amounts from a DATA statement, and then produces an output like the one that follows.

```
RUN

AMOUNT          BALANCE

                  300
  45.67           254.33
  23.12           231.21
 145.98            85.23

DONE
```

NORTH SALEM HIGH SCHOOL
SALEM, OREGON

North Salem High School strives to achieve computer literacy for all students with low-cost computing facilities.

SIZE

1500 students, grades 9-12. 100 faculty.

One of the 4 high schools in the Salem School District.

STUDENTS

Students are from middle to lower income families living in the city.

North Salem's student body is predominately white. Students of Spanish descent constitute the largest minority group. The black population is increasing and there are some Korean and Vietnamese students.

35% of the graduates attend college; 20% seek additional formal training at an institution not classified as a 4-year college.

CURRENT ISSUES

The District's budget is often a source of uncertainty, which makes planning difficult. Voters have direct control over the annual budget, and measures similar to California's Proposition 13 are expected.

The Comprehensive Education Process, (CEP), an on-going project to improve curriculum coordination in the District, began in 1973. The CEP is making explicit the major things which students should know, do, or feel through their schooling experiences.

North Salem constructed in 1937, is currently engaged in a large building renovation project.

The Past Sixteen Years

A major factor in the growth of academic computing at North Salem was their participation in the regional Computer Instruction Network (CIN). With the advent of microprocessors, the program has expanded on a minimum budget.

1962	Mrs. Marian Putnam offered one-month programming units in machine language on an ECP-18 computer.
1965	Salem School District, the State Department of Education, and Marion County Intermediate Education District cooperated in a proposal for a computer network under Title III of the Elementary and Secondary Education Act.
1966	Forty secondary schools in a four-county area participated in an 8-month planning phase for their project.
1967	The grant was funded. Computer Instruction Network (CIN) operated through the Marion County IED. CIN received $100,000 per year for three years.
1967-70	Teachers received computer programming education through classes offered by CIN, especially teachers from the forty participating schools
1968-70	North Salem participated in the Computer Instruction Network (CIN). Computer programming was introduced into the high school curriculum.
1970	Salem Public Schools purchased a DEC PDP 8I from CIN.
1972	North Salem made arrangements for time-sharing services from Oregon State University.
1974	Mr. Jaquiss was hired to teach computing at North Salem. Two courses, Introduction to Computers and Advanced Computer Programming were offered.

1975	DEC Classic was purchased on 5-year plan to replace time-sharing terminal.
1975-77	Oregon Mathematics Education Council (OMEC) from funds made available by the National Science foundation, awarded a grant to Mr. Jaquiss to teach night classes for teachers (Computers in Education and Computer Programming in BASIC).
1976	Traveling computer terminal was made available to teachers throughout the District on an experimental basis. North Salem students began to access the computerized Career Information System (CIS).
1977	IMSAI microprocessor purchased. Instructional software in several disciplines was adapted for use on this system.
1978	Commodore 2001 PET computer purchased. IMSAI used to demonstrate computer programs relevant to subject area classes. Multnomah County Educational Services District funded a committee, including Mr. Jaquiss, to write course goals for Computer Education. The product of this committee will be a book, the latest in a series of subject course goals (K-12), written under the auspices of Multnomah County ESD, the Tri-County Area, and the Portland Public Schools.

Organization and Management of Academic Computing

The Salem Public Schools have centralized facilities for administrative computing. Each school in the Salem system organizes and manages its own instructional computing program.

MANAGEMENT

At North Salem, Mr. Robert Jaquiss, a teacher in the Mathematics Department, teaches all computer courses. He manages the computer systems, software and courseware development, and does all planning, including equipment acquisition and budget proposals.

Budget control is the responsibility of the Principal, School Board and Superintendent.

STAFF

Students provide operations and programming support.

SUPPORT

Strong District administration support for instructional computing is lacking.

Budgetary constraints force administrators to consider limiting expansion of, or dropping, computing programs.

A committee for computer education was discussed but never established.

FACULTY INCENTIVES

Training for interested teachers in the District was provided in 1975-77 in free evening classes taught by Mr. Jaquiss [4, 5, 6].

Funding for these courses came from the National Science Foundation to the Oregon Mathematics Education Council (OMEC) to Mr. Jaquiss.

A total of 43 teachers participated. Teachers received graduate credit from the Division of Continuing Education through the University of Oregon.

The Oregon Mathematics Education Council paid for summer school courses for Mr. Jaquiss for three years.

The District has granted professional leave and paid expenses to enable Mr. Jaquiss to attend several computer conferences.

Student Access to Computing

COMPUTERS AND TERMINALS

- DEC PDP 8I with an ASR 33 TTY
- DEC CLASSIC with DEC VT-50, LA-35 DECwriter, and ASR 33 TTY
- IMSAI, Z-80 CPU with VDM-1, ASR 33 TTY, dual floppy disks
- Commodore PET

Access to Willamette University in Salem for the Career Information System (CIS).

WHERE

Two locations in the high school:

Guidance Department, and
Computer Education classroom.

HOW

Appointments are made by students to use the Career Information System.

Students have access 9 hours each day to the above equipment located in the Computer Education classroom. The one-user systems do not require formal account numbers.

Costs and Budgeting

FUNDING

Instructional computing at North Salem is currently funded by their local District. In the past they received some Federal funds from Title III for the Computer Instruction Network and from the Oregon Mathematics Education Council. The policy at North Salem is to promote low-cost computing.

BUDGET HISTORY

1973-77	$5,130 per year
1977-78	$6,000

Figures include lease, purchase, and maintenance of equipment for instructional computing at North Salem High.

Student Accomplishments

Computer Science students' accomplishments at North Salem are reflected in the projects they undertake.

PROJECTS

Advanced students have contributed system software for the various computer systems at North Salem. Many of these modifications have increased the ease of using the systems.

Students have adapted programs, including the Huntington II simulations, to run on several of the computers.

Students have demonstrated instructional computing applications to teachers with no computing experience and their classes.

Students developed a series of programs to teach concepts in Personal Finance classes, as well as programs to be used by the Finance teachers to prepare their ditto masters.

A student developed a version of the FOCAL language processor for the DEC CLASSIC system to provide other students with more varied programming experiences.

Spectrum of Applications

Computer Science students are the primary computer users at North Salem. They are currently adapting programs relating to other discipline areas, for use on their small computers. One computer will travel to various subject area classrooms. Programs ready, but not yet in use, include:

- Business simulations
- Chemistry tutorials
- Social Science simulations
- Physics and Chemistry simulations
- Personal Finance programs to teach about loans and interest rates

GUIDANCE

Career Information System (CIS) is used by 700 students per year, and by all students before graduation.

Computer Literacy

Computer literacy is the major goal of North Salem's academic computing program.

FOR: All students, interested faculty and parents.
50 students/year participate, grades 9-12.

BY: Mr. Jaquiss, Computer Teacher in the Math Department

SINCE: 1974

PROGRAM

Introduction to the Computer (one semester). This course is an introductory course to provide the student with some knowledge and experience to help him determine if he wants to take further classes in computer science. The objectives are to give the student sufficient understanding regarding the way computer works to allow him to give examples of what computers can and cannot do. The student is given examples of numeric and non-numeric applications of the computer in our society, and is able to state some of the implications of various uses (and misuses) on individuals and on society. The student learns the contribution of the computer to problem-solving, including the concepts of algorithms, programming, modeling, and simulation. The student has the opportunity to use the computer in a meaningful way which will reduce the common feeling of fear of the computer.

IMPACT

Mr. Jaquiss' goal is to have high computer literacy at North Salem. He has compiled extensive information defining and describing literacy for students, faculty, and administration.

Computer Science

The main focus at North Salem is computer literacy, but many varied opportunities are provided for advanced students.

FOR: Interested students, grades 9-12.

25 students/year participate.

BY: Mr. Jaquiss, Computer Teacher in the Math Department

SINCE: 1968

PROGRAM: Courses offered:

- BASIC Programming
- Advanced BASIC Programming
- FORTRAN Programming
- Assembler Programming

All courses last one semester.

Advanced courses center around individual study projects.

Computer Science students receive credit that may be used to fulfill Career Education requirements.

COST: Cost per student per year for equipment and maintenance only is approximately $100.

Lessons Learned

EQUIPMENT

After trying to purchase a system to "do everything," Mr. Jaquiss now believes that many educational applications do not require a powerful central computer. In fact, many interesting projects can be accomplished with microcomputers. Even a $1000 computer system offers potential for the hands-on use of a computer, including several advantages (e.g. screen graphics) not available in expensive time-sharing computer systems. The main disadvantage, particularly with several different models of microcomputers, is the lack of standardization among them. Unlike a time-sharing system where one program can serve many users, each different microcomputer may need its own version of the same program for its users.

Since the products on the market are changing so rapidly, Mr. Jaquiss hopes people planning for academic computing will be "allowed" to wait until they have the money to choose a computer. For example, in many schools, budget requests (including specifying a particular microprocessor and its price) for Fall 1979 were made in September 1978.

It is preferable to buy microprocessors that currently exist in your local computer store rather than simply in advertisements. Advertisements for computer products tend to be overly optimistic about good features and neglect to mention negative features. In addition, with a computer literacy focus, it is better to buy units that are already complete, assembled, and tested by the computer store.

The potential buyer must look carefully at the advantages and disadvantages of time-sharing minicomputer systems as compared to individual offerings in new microprocessor systems. Mr. Jaquiss also believes that criteria for evaluating computer systems have changed drastically in the years 1976-78. Although it is easy to calculate the cost per user-station per hour, it is very difficult to evaluate the intangibles of what the system will do for the user(s).

SOFTWARE

BASIC is an easy-to-learn language, and thus a good way to begin. BASIC may not be the ultimate in higher-level languages. Planning should include the potential for implementing other languages (e.g., Assembler, FORTRAN, PASCAL, etc.).

USE

The computer should be used throughout the curriculum. Teachers must be trained. This process is possible, but slow and difficult. In general, teachers should:

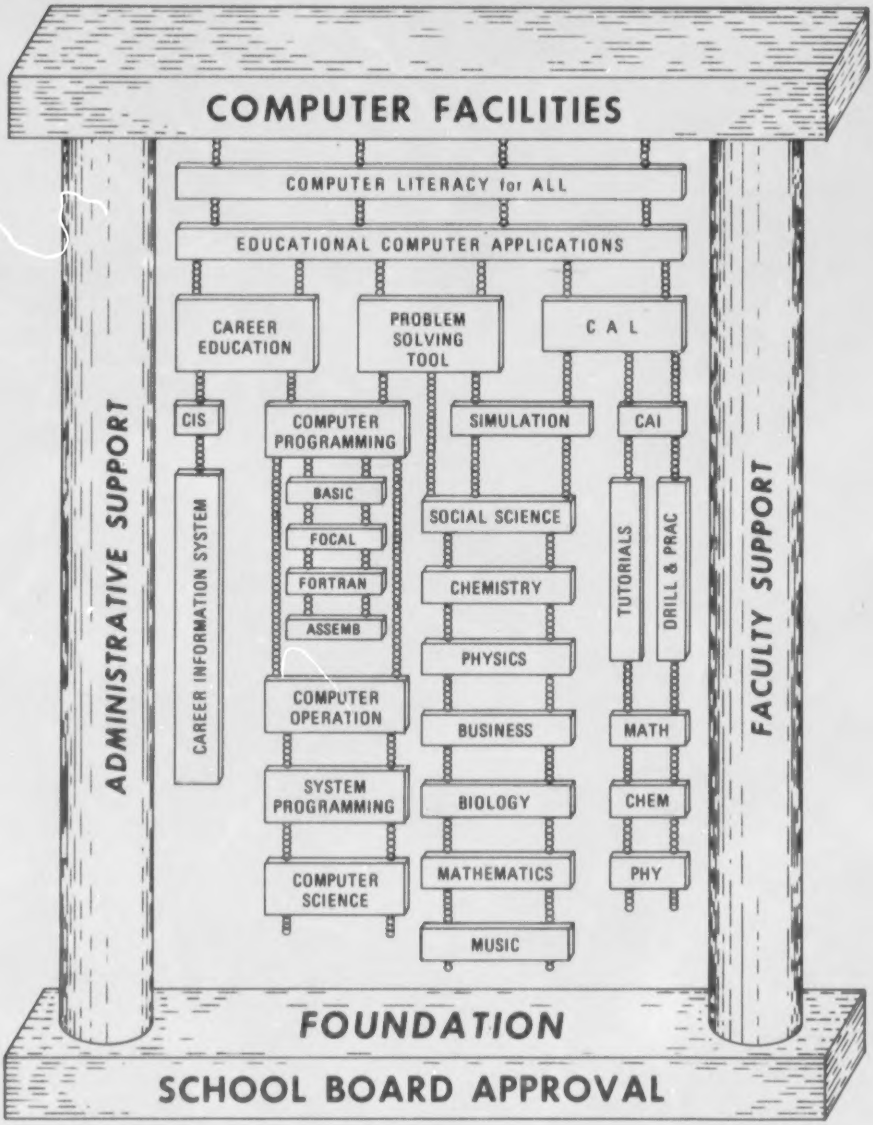
- expect to make mistakes;
- expect some students to be better programmers than they are; and
- prepare to revise computer class lesson plans every term.

Revisions are necessary because of changes in the number and interests of the students enrolled, and because of changes in computer equipment. For example, a class of 25 students using 3 computer "terminals" can proceed quite differently than the same class with only one user-station.

ADMINISTRATIVE SUPPORT

Administrators are busy, have budget constraints and conflicting priorities, and are rarely well informed about academic computing. They must be "convinced," for their support is essential. Although the strength of that support is important to building a successful program, many gains can be made by dedicated individuals.

Figure 1 is a structure designed by Mr. Jaquiss to describe his perspective on the support required to use the computer successfully in all facets of the instructional process.


COMPUTER FACILITIES
COMPUTER LITERACY for ALL
EDUCATIONAL COMPUTER APPLICATIONS
CAREER EDUCATION
PROBLEM SOLVING TOOL
C A L
CIS
COMPUTER PROGRAMMING
SIMULATION
CAI
CAREER INFORMATION SYSTEM
BASIC
FOCAL
FORTRAN
ASSEMB
SOCIAL SCIENCE
CHEMISTRY
PHYSICS
BUSINESS
BIOLOGY
MATHEMATICS
MUSIC
TUTORIALS
DRILL & PRAC
MATH
CHEM
PHY
COMPUTER OPERATION
SYSTEM PROGRAMMING
COMPUTER SCIENCE
ADMINISTRATIVE SUPPORT
FACULTY SUPPORT
FOUNDATION
SCHOOL BOARD APPROVAL

Plans and Goals

EQUIPMENT

Mr. Jaquiss is proposing that North Salem purchase an additional microcomputer system (in the $6,000 - 10,000 range) depending on the amount each year of financial support for the program. The decision must be made of whether to:

1. use available money to add more memory or floppy disk system to existing computer systems, or
2. to purchase additional less capable computer systems to enable more students to have hands-on computer experience.

He is hoping to do both of the above as well as purchase a color graphics microcomputer, perhaps the Compucolor.

Mr. Jaquiss says:

> "I foresee an intelligent terminal network with each terminal being able to access a large intelligent disk data base. The intelligent terminal will go to the disk to get whichever language processor is desired and copy it into memory. Then the intelligent terminal will access the master disk again to load or save programs. The intelligent terminal will be able to execute the desired program in the selected language. A user will be able to select a CRT terminal or a printing terminal from which he can control a high speed line printer and a high speed paper tape punch or reader. Jacks will be provided in classrooms so that any terminal may be plugged in. Color graphics with color camera copier, a plotter, and a line printer capable of 200 dots per inch resolution on the system is not too much to ask in the near future."

SOFTWARE

Plans are being made for additional language capabilities (e.g., PASCAL).

USE

The traveling computer will be used in several disciplines. Plans are underway to expand instructional computing to be a routine part of courses other than Computer Science. The new PET, along with canned programs, will be loaned to the junior high and elementary schools.

Mr. Jaquiss thinks it would be a good idea to have a Computer Literacy class as a requirement for high school graduation. However, rather than teaching a required course, he prefers to try to make the Computer Literacy class attractive and desirable so that students will want to take it.

Contact

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Robert S. Jaquiss, Sr.
Computer Teacher

References

Mr. Jaquiss has written many documents concerning the use of computers in education for the decision-makers in the Salem School System. The major topics of these documents are: writings on computer literacy; advantages, limitations and costs of various alternative equipment configurations; course objectives and descriptions; definitions of terms; information on available resources; and samples of computer use in the classroom.

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2. Jaquiss, R.S. *Proposal for Computer Facilities in the Salem Public Schools.* North Salem High School, August 1977.
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RIDGEWOOD HIGH SCHOOL
RIDGEWOOD, NEW JERSEY

The Ridgewood High School Computer Resource Center serves students throughout the School District as well as the community.

Profile

SIZE

Ridgewood is the high school in Ridgewood New Jersey's Public School District. The high school has 1600 students in grades 10-12.

The faculty of 110 teachers, 8 counselors is highly trained; the majority of teachers hired in Ridgewood have both experience and advanced degrees.

Ridgewood School District includes 2 junior high and 7 elementary schools in addition to the high school, a total of 6000 students.

STUDENTS

Students 96% white, 4% minority.

81% pursue post-secondary education.

Upper middle-class community of professional people.

CURRENT ISSUES

The Board of Education in cooperation with the community, faculty and high school students developed and published goals for the Ridgewood Public Schools. The four general goal areas are Scholarship, Character, Citizenship and School Performance [2].

District enrollment is declining.

A recent State law, the goal of which is to promote equal educational opportunity, strives to equalize per pupil spending throughout New Jersey. This fiscal policy will restrain the Ridgewood District from increasing the school budget to meet inflation. Departments are, therefore, forced to justify expenditures and curtail new programs.

The Past Twelve Years

The growth of instructional computing in Ridgewood has been possible because of strong administrative support. The many, diverse applications available are a result of Ridgewood's staff being highly trained and participation in the Wayne, New Jersey Computing Consortium.

In the past twelve years, Ridgewood High School:

1966	Offered first faculty training for academic computing in County education workshops.
1967	Offered first course in computer science.
1968-69	Leased an IBM terminal ($12,000/year) and keypunch.
1969-70	Bought time on GE computer at a commercial time-sharing company ($15/hour). Began to demonstrate the use of the computer to entire classes (e.g., algebra).
1970-71	Bought time on a DEC PDP 8 from TRANSNET.
1971	Rented access for four simultaneous users from the Wayne, New Jersey Computing Consortium with which they continue to be associated, in order to use a guidance system (GIS) and a math drill and practice package.
1974	Purchased their own computer, a DEC PDP 11/40, which has the capacity of running 10 terminals simultaneously.
1978	Purchased commodore PET for demonstrations in elementary schools. Purchased programmable calculators for junior high schools.

Organization and Management of Academic Computing

The Ridgewood Computer Center is dedicated to instructional computing. All administrative computing is handled elsewhere.

MANAGEMENT

A Coordinator of Instructional Computing manages the various aspects of academic use of the computer. This coordinator works one-half time for the District and reports to the Assistant Superintendent of Instruction. A primary duty is to manage the Computer Resource Center. The other half of her time is spent as a Computer Science teacher in the Math Department. This Coordinator receives a stipend for assuming these additional responsibilities. Other Ridgewood teachers help with supervision of the Resource Center.

COMMITTEES

One committee is studying and proposing upgrades for the computer equipment; a second is planning, developing, and implementing additional computer-based instructional materials.

FACULTY INCENTIVES

Faculty in-service has been provided for the past 10 years.

Local colleges also offer courses in computing. All mathematics teachers, as well as teachers in several other disciplines, are well trained in computing.

Faculty who develop computer-based instructional materials receive in-service credit that counts toward salary increases and promotion.

A paid full-time position is provided for management of Computer Resources Center and materials development.

Stipends are provided for the advisors of junior high and high school computer clubs.

Faculty memberships to professional organizations (ACM and AEDS) are paid for by the District budget.

Staff members attend conferences, conventions and workshops at local school expense.

Student Access to Computing

One goal of Ridgewood's Computer Resource Center is to schedule the computing facilities for maximum use by District students and community members.

COMPUTERS

- DEC PDP 11/40
- Special-purpose computer in the Graphics Art Department
- DEC LSI-11 Microcomputer in the Drama Department
- Access to HP 2000 in the Wayne, New Jersey Computing Consortium
- Commodore PET microcomputer
- Programmable calculators

TERMINALS

2 DECwriters
1 ADDS (CRT)
5 Digilog Keyboards
7 Digilog Monitors
8 TTYs
1 Cardreader
1 Sorter
2 Keypunches

USERS

100 annual student users/terminal, assuming 1500 annual users for 15 terminals.

WHERE

Terminals in six locations in the school, including a Computer Resource Center.

HOW

Account numbers are issued to departments, courses, faculty, special projects, and clubs. A general users account is available.

Computer Resource Center is open 8-12 hours each day, and is supervised by teachers.

Costs and Budgeting

FUNDING

100% local District funding for instructional computing.

BUDGET HISTORY

District budget (excluding staff):

1967-68	$11,000
1969-70	$ 7,800
1973-74	$22,000
1976-77	$32,726

Figures include equipment, maintenance, and supplies for instructional computing. The Graphics Art and Drama Departments' computers are not included.

Student Accomplishments

Categories of student accomplishments at Ridgewood include:

- awards
- basic skills
- projects

AWARDS

Ridgewood students won the 1973 and 1977 National Computer Conference student fairs.

Two to four students per year attend special honors summer or Saturday programs at local colleges in computer science.

Ridgewood students have received 1-3 hours credit in computer science after entrance examinations at their respective colleges.

BASIC SKILLS

A pilot study shows remedial mathematics students (three 10th grade classes) made achievement gains in the basic skills of fractions, decimals and percentages according to State Assessment Tests. A series of mathematics drill and practice programs were developed for this project. Greater gains were reported for students who were supervised rather than independent users of the programs [1].

The number of 6th grade underachieving spelling students at the Hawes Elementary School has decreased, according to spelling scores on the Metropolitan Achievement Tests, as a result of their use of a computerized spelling program [4, 5].

PROJECTS

A student-written program is published in Hewlett-Packard Library Handbook.

REFERENCES

Reports are available on the two above projects in basic skills [1, 4, 5].

Spectrum of Applications

MATHEMATICS

Nearly every class in grades 7-12 has some computer experience. The activities are either class demonstrations, homework assignments, or individual programming projects. Various strategies including drill and practice, problem solving, simulation, tutorial and programming are used. CAI is used for special education students and remedial work.

Probability-Statistics. Research projects and surveys are conducted; students use the computer to analyze their data.

Algebra II with Computer Programming. A special elective course. The curriculum is a modification of the University of Colorado project [6].

Algebra I and II. Special programs have been designed to help students develop problem-solving skills.

Calculus (Advanced Placement). Each student develops problem-solving techniques with recursion relations and iteration procedures.

Geometry. Tutorial programs have been developed for the units on coordinate geometry.

General and Consumer Mathematics. Students use simulation programs concerning mortgage, compound interest, loans, and savings.

SCIENCE

50% of staff and teachers in grades 7-12 use the computer in their science courses.

General Science and Biology. Huntington II and special student-constructed simulations such as genetic programs are used.

Physics. All students and staff. Students are given special projects using the computer. A dedicated terminal is located in the Physics Project area.

Chemistry. 10% of students. Students develop simulation and self-teaching projects.

SOCIAL STUDIES

About 20% of the students and teachers from grades 7-12 use the computer in their classes. The Huntington II simulation programs and the Stanford Graduate School of Business economics programs are used most frequently.

Psychology. This class uses the computer to illustrate the learning process and different types of learning and reinforcement.

Stock Market. This class uses stock market simulation programs.

Economics. This class uses the simulations Fiscal Policy Game and Economic Policy Game, programs developed at the Stanford Graduate School of Business.

U.S. History I and II. These classes use economic policy-making problems and other simulated programs such as election surveys and Civil War simulations.

BUSINESS EDUCATION

50% of the students use the computer. An experimental curriculum integrates the use of the computer in such areas as accounting, business machines, and consumer education. A sorter and a keypunch are located in the business machines room.

ENGLISH

50% of the students use the computer.

Remedial drill on homonyms for selected students.

Some students demonstrate the computer as a speech project.

FOREIGN LANGUAGES

Approximately 20% of staff and teachers in grades 9-12 use the computer. Spanish and French classes use student and teacher constructed drills and self-testing programs.

ART-HUMANITIES

50% of teachers and students.

Humanities. All students and teachers use special programs designed for a unit called "Man and the Machine."

Art. 10% of students. Students create a design on a grid which they enter as data into a program that generates their art design and its negative.

HEALTH EDUCATION

25% of students and teachers. Classes use simulation programs such as Diet, Genetics, and student-constructed simulation and self-teaching programs.

INDUSTRIAL ARTS

50% of students and staff. Teacher and students do special service projects using their own specially designed computer.

GUIDANCE

Students access Guidance Information System (GIS) for career and college.

PHYSICAL EDUCATION

All students use teacher-developed programs to measure their weight and body ratios.

EXTRACURRICULAR ACTIVITIES

The Drama Club controls stage lighting by programming a microcomputer.

Computer Club in the junior high and high schools.

Computer Literacy

FOR: Elementary and junior high school students in the District.

BY: Ridgewood High School Computer Resource Center.

SINCE: 1975.

PROGRAM: Elementary classes make one-half day visits to the Computer Resource Center at the high school. Staff and children exchange letters, compositions and art work before and after the visit.

Introduction to Vocations is a 9th grade elective course. Students spend three, one-half days at the Computer Resource Center. Activities include hands-on experience with the computer equipment and learning where the computer and computer applications can support their potential career development.

Computer Science for junior high students meets 2 days/week, 1 hour/day. The course, primarily for the top students, is administered by the Math Department.

IMPACT: Many Ridgewood students have had some exposure to computing before high school.

Computer Science

FOR: 250 Ridgewood students, grades 10-12, each year.

BY: Coordinator of Instructional Computing in conjunction with the Mathematics Department.

SINCE: 1967.

PROGRAM: Course titles are:

- Computer Science I: Time-sharing BASIC
- Computer Science II: Batch FORTRAN

Students may also take Independent Study in Computer Science.

The courses help students prepare to use the computer in other academic areas, for job placement and for background to college.

TEXT: Experimental textbook materials have been developed at Ridgewood for both courses.

Outreach

COMPUTER-BASED LEARNING MATERIALS

Instructional programs developed at Ridgewood are shared with institutions outside the district.

COMPUTER FACILITIES

The Ridgewood High School Computer Resource Center has been the host for:

- Evening adult school classes
- Free summer evening workshops for community members
- Classes for local junior high and elementary students
- Seminars for teachers associated with the Wayne, New Jersey Consortium
- Amateur Radio Association and Northern New Jersey ACM Secondary School Club Meetings
- Visits of local community college classes and other secondary school computer clubs.

Computer Resource Center publishes a newsletter, *Output*.

EXPERTISE

Computer Resource Center personnel speak at conferences and workshops. The supervisor of the Center has been the Chairperson of the Northern New Jersey ACM Secondary School Computer Clubs.

COMMUNITY SERVICES

Ridgewood students participated in a special project demonstrating the use of the computer in the Ridgewood Public Library.

Lessons Learned

ORGANIZATION

Ms. Marilyn Spencer, Coordinator of Instructional Computing at Ridgewood, believes that the most successful programs are those that separate academic and administrative computing. Because of the diverse interests of the two groups, she recommends both a separate staff and separate computer for instructional use.

Ms. Spencer feels that the two components crucial to a successful program are strong administrative support and a qualified staff to implement the program.

She advises involving as many faculty as possible in the program and, if possible, providing salary incentives for participation (e.g., teaching an adult school class). She also peels that ongoing inservice training is a crucial component of any computer program.

She warns that progress is slow in building a quality program.

Plans and Goals

Plans for 1978-1979 were outlined in a memorandum to the Ridgewood High School principal.

EQUIPMENT

Ridgewood is studying the purchase of a microprocessor for the Physics Department, preferably one with graphics.

A major problem which must be solved at Ridgewood is that the present computer system's 10 terminal capacity cannot fully serve the number of interested students and trained faculty members.

COMPUTER-BASED LEARNING MATERIALS

Curriculum for elementary school students will be developed for the Commodore PET microprocessor. The PET will then travel to the elementary schools for use by the students.

Ridgewood is planning to integrate a computer literacy unit into the seventh grade mathematics curriculum for all students.

Ridgewood is restructuring the computer science curricula to meet the needs of students on three levels of expertise and is increasing the amount of student involvement in operating the computer system.

Programs are being developed in special education. Teachers are now developing English programs, and refining and expanding remedial mathematics programs.

They are integrating units using the computer into accounting, business and science courses.

Plans are being made to integrate the use of programmable calculators into the junior high school curriculum.

Contacts

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Robert Muller
Computer Science Teacher

George Washington Junior High School
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Denis Kaminski
Computer Science Teacher

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RIVERDALE COUNTRY SCHOOL
BRONX, NEW YORK

Riverdale, a private educational institution, offers a diversified college preparatory curriculum. Students at all levels (grades K-12) use the computer in their instructional program.

Profile

SIZE

Private, coeducational institution of 950 students, K-12; 100 full-time faculty.

STUDENTS

84% from upper middle-class families; 16% scholarship students; 99% graduates attend college.

CURRENT ISSUES

The school offers a diversified college preparatory curriculum. Riverdale has one of the largest scholarship programs in the New York area. It is a financially sound institution.

The Past Eight Years

The computer program at Riverdale began in 1970 and has grown steadily since then with primarily local funding.

A major factor in the early growth of computing at Riverdale was the accessibility of computer facilities at a nearby private school.

1970	Leased first terminal; purchased computer time from a commercial time-sharing service. Initiated a computer science curriculum.
1971	Hired Bruce Alcock to teach mathematics and the computer science course.
1972	Leased second terminal. Considered purchasing their own computer. Took delivery of Data General NOVA on a trial basis. Returned the NOVA because not enough schools were sharing its cost. Began to use DEC PDP 11/20 at the Spence School, a private girls' school in New York City.
1973	Purchased portable terminal for students to take home. Planned first administrative applications.
1974	Purchased two more terminals. Offered first workshop for faculty in conjunction with Spence School. Began development of Math Strands.
1975	Rewrote Math Strands based on user comments. Integrated computer literacy units into the 8th and 10th grade math curriculum.
1976	Developed first version of a computer-based English curriculum. Purchased portable CRT.
1977	Purchased their own computer, a DEC PDP 11/34, to handle up to 123 terminals. Increased the number of administrative applications.

Sold computer time to two schools.

Rewrote Math Strands with curriculum changes suggested by a user school.

1978 Added memory, disk storage, and additional ports to the computer system.

Sold computer time to five schools.

Created official position, Director of Computer Center, for Bruce Alcock.

Began development of a new English program for grades 5 and 10.

Organization and Management of Academic Computing

The Riverdale Computer Center serves both the instructional and administrative needs of the school. They also sell computer time to other private schools.

MANAGEMENT

Director of the Computer Center, Bruce Alcock, manages administrative and instructional computing.

STAFF

Students are the staff for the Computer Center, including the System Manager and the Assistant System Manager.

SUPPORT

Students provide systems and applications programming support. Student Managers responsible for operations, back-up and account management. The students volunteer, but are paid for summer work.

The Student System Manager handles all communications with schools that rent time on the system. A secretary/administrative assistant was recently added to the permanent staff to help with educational as well as administrative work on the computer, including routine tasks for the Math and English Strands such as enrolling students and printing and distributing reports for teachers.

Student Access to Computing

COMPUTER

DEC PDP 11/34

TERMINALS

16 terminals; 15 for instruction, one for administrative applications. Several are portable for home use.

3 DECwriters
2 Texas Instruments, Silent 700
5 ADDS
2 Portable ADDS
1 Execuport
2 TTY
1 Diablo (for administrators)

USERS

30 student users for every terminal, based on 450 annual users.

WHERE

Terminals in 5 campus locations for student use:

Upper School terminal room
Middle School Math Lab
Lower School Math and Reading Room
2 classrooms

HOW

An account number is issued to any student or teacher requesting one. Eighth and tenth grade mathematics students use class accounts for their computer literacy units. Currently, only advanced students are issued individual accounts. Highly competent and responsible students have privileged accounts. Most students share accounts with one or two classmates. Math and English Strands accounts are issued upon request, usually by faculty.

Costs and Budgeting

FUNDING

All funding for computing is in-house. 75% of the total computing dollars is spent on instructional computing.

The budget is approved by the Headmaster.

BUDGET HISTORY

	Total Computing Budget	Instructional Computing Budget	Total School Budget
1973-74		$ 7,000.	
1976-77	$22,000.	17,000.	$3,433,562.
1977-78	25,000.[1]	19,000.	3,688,152.
1978-79 (estimated)	18,000.[2]	13,000	3,866,293.

Approximately $13. per student per year is spent for instructional computing.

These figures do not include faculty and staff salaries, just computer and supply costs. (Administrative costs include the purchase of forms.)

In 1977 the Helena Rubenstein Foundation gave Riverdale a grant to purchase two terminals for the Lower School. This has been the only outside funding to date.

Schools renting time are charged a fixed amount per port per year for unlimited access time and CPU usage. The aim is to encourage and share educational computer usage.

---

[1] Inflated figure due to computer purchase.

[2] Begin to realize cost savings due to system purchase in 1977.

Student Accomplishments

Categories of student accomplishments include:

- student projects
- employment
- attitude changes

PROJECTS

Student-written administrative and instructional programs.

Major project: students wrote Math Strands, a version of the 6-year math curriculum developed at Stanford [8].

Math Strands is a drill-and-practice curriculum for elementary level mathematics students. Drills are organized according to topics, or strands, and individuals work in each strand at their own pace.

Students wrote a management and reporting package to accompany the math curriculum.

Students made presentations on Math Strands at the 1977 National Computer Conference [1, 4], and Fall 1977 DECUS meeting.

Two students gave a presentation on system programming at the Spring 1978 DECUS meeting.

A student took a portable terminal to a local public school and worked with fourth graders on Math Strands.

EMPLOYMENT

Four students were employed during the summer of 1978 as programmers; one at a major computer manufacturer, one at a Manhattan hospital and two at time-sharing bureaus. Another student working at the school does occasional contract work in Assembly language for the DEC LSI-11 microprocessor.

ATTITUDES

The Math Strands program has had a positive effect on attitude and motivation toward mathematics.

> "The teachers of grades one through six feel there is an improvement of performance in mathematics. They have received useful feedback on the performance of individual students and classes as a whole which has caused them to make modifications in their computer sessions. An attitude questionnaire was administered recently to the students in grades one through six. The responses to the questionnaire indicated that, in addition to enjoying their computer sessions and wanting more of them, using the computer made the students feel 'smarter,' 'proud of myself,' and 'relaxed.' Interest in classroom mathematics has been stimulated." [9]

REFERENCES

[1, 4, 8, 9].

Spectrum of Applications

The majority of computer use at Riverdale is in mathematics and computer science. Eighty percent of the math teachers use the computer in their courses.

MATHEMATICS

The computer is used for programming and problem-solving in nearly all math courses.

Elementary students (1-6) use Math Strands for drill and practice. All students in these grades are required to run a specified number of sessions per week. Teachers get reports on student progress to make certain that the students complete the required number of sessions and to look for areas of weakness for each individual.

SCIENCE

Tests are entered and edited via the computer in a word-processing application.

Chemistry: Statistics on experiments are gathered class by class, and comparisons made calculating mean deviation for all classes. Success of individual's experiment is based on deviation from mean. Also, some curriculum testing is done, tailored to course given by the specific instructor.

ENGLISH

Grammar and spelling drills. College Board vocabulary drill.

A new English Strand program for grades 5 and 10 is being tested in the Fall, 1978. Grade 5 strands include punctuation, spelling, vocabulary and grammar usage. Grade 10 strands are punctuation and syntax.

FOREIGN LANGUAGE

Vocabulary drills: Teachers choose word lists that are then entered by students. Some record keeping is done. More work by teachers is planned as they want more control over multiple-choice items.

EXTRACURRICULAR ACTIVITIES

Computer Club

School newspaper/newsletters done using the computer.

HOMEWORK

Students use the word processing capabilities for English and History papers.

Computer Literacy

FOR: All 8th and 10th grade students; interested 5th and 6th graders.

BY: Regular mathematics teachers.

SINCE: 1974.

PROGRAM: A two-week unit in programming during 8th and 10th grade mathematics.

TEXT: *A Guided Tour of Programming in BASIC* [5] for grades 5-6, BASIC BASIC [3] for grades 8, 10, and materials developed by mathematics teachers at the school.

IMPACT: All students learn computer programming skills before graduation. Due to the use of educational programs in the Lower grades, more students are familiar with the basics of using a computer by the time they reach 8th grade, and interest is generated at the lower grades to learn programming.

FUNDING: Regular course.

- -

FOR: Teachers.

SINCE: 1974.

PROGRAM: Annual workshops train new teachers and review techniques with teachers who know programming.

Focus is on programs that can be used by the teachers in their classes.

IMPACT: All mathematics teachers have had some exposure to the use of the computer and programming.

Computer Science Curricula

FOR: 11th and 12th grade students as electives; 35 students/year.

BY: Computer Science teachers from the Mathematics Department.

SINCE: 1971.

PROGRAM

Introduction to Computer Science (1/2 year; 1/2 credit)

This course is intended for students with a special interest in science and mathematics. Topics covered include the general theory of hardware and software, computer circuitry, Boolean algebra, assembly language programming, compilers and operating systems. A term project is required.

Advanced Programming Techniques (1/2 year; 1/2 credit)

The course introduces advanced features of Basic-Plus as well as advanced problem-solving techniques and some basic systems analysis. Topics covered include string functions, matrices, files (virtual core arrays, formatted ASCII and Record I/0 and systems functions. A term project is required.

Computer Applications in Mathematics (1/2 year; 1/2 credit)

This course deals with the use of the computer to solve selected types of mathematical problems. Topics are chosen from elementary number theory, numerical analysis, probability and statistics, elementary functions, and matrix algebra.

Computer Applications in the Social Sciences (1/2 year; 1/2 credit)

This course is for students interested in new approaches to solving problems in various areas of the social sciences, from urban planning to economic forecasting. The use of simulation models on the computer is studied. Flexibility of planning is maintained in order best to meet the needs and interests of the students involved.

Independent Study (1 year; 1 credit or 1/2 year; 1/2 credit)

At the discretion of the department. A written proposal must be submitted before registration.

IMPACT

The enrollment in these courses varies and seems to run in two-year cycles. Last year 35 students were enrolled in two courses. The courses tend to be offered every other year depending on interest and are open to all 11-12 graders.

The purpose of the courses is to meet the interest of the students and prepare them for college rather than vocational training. Some students, however, do obtain summer jobs as programmers.

FUNDING

Regular courses in the Mathematics Department budget.

Outreach

COMPUTER-BASED LEARNING MATERIALS

The Math Strands has been distributed to 10 schools with assistance provided by Riverdale.

EXPERTISE

Riverdale has organized a local users group for educational institutions in the New York area.

Riverdale publishes the DECUS EDUSIG Newsletter [5], which is distributed to 2200 schools and colleges.

Students and faculty are active in various professional organizations. Riverdale welcomes visitors from the area and responds to written inquiries for advice from all over the country.

Plans and Goals

COMPUTER-BASED CURRICULAR MATERIALS

One of the highest priorities at Riverdale is the completion of the computer-based English curriculum, including grammar and spelling, which they believe are needed for both drill and remedial work.

They are studying the implementation and/or modification of various CAI authoring languages (e.g., DECAL, Coursewriter, PILOT) on their system. Through DECUS (DEC Computer Users' Society), they have access to educational materials written in PILOT which cannot currently be run on their system.

EQUIPMENT

Their most immediate need now is increasing the number of terminals at the school. Riverdale also plans to continue upgrading their computer system. For the long term, they are studying the application of microprocessors as the network nodes of a more cost-feasible network, rather than as stand-alone units. They also hope to work with graphics and animation, perhaps using microprocessors.

On the subject of microprocessors, Mr. Alcock advises others in academic computing to be cautious. He warns that while microcomputers are a low cost method of gaining computer capabilities, a complete microcomputer with floppy disks is not inexpensive. Relatively little software has been developed for most of the systems thus far. Cassettes, digital or audio, are impossible to use for CAI type applications, from a practical point of view. Once an inadequate microcomputer is acquired, the school administration might not want to fund expansion, since the school already has a "computer."

A microcomputer usually has one terminal. In the school environment, the number of terminals is important since 1,000 students cannot use one terminal (they could each use it perhaps once a year).

They have estimated that to have a fully implemented program, teaching uses of the computer, CAI and other education applications, the number of terminals should equal ten to fifteen percent of the student enrollment.

Lessons Learned

COMPUTER-BASED CURRICULAR MATERIALS

Bruce Alcock of Riverdale believes that "finished instructional software" is one key to successful academic computing. Teachers who, in general, do not write their own texts, will not produce their own instructional computer programs. Pressure should be placed on the government to start the curriculum development, and on manufacturers and publishers to produce quality packages that are flexible and easy to use.

USE

Mr. Alcock advises that one should not try to use the computer in too many curricular areas at once without adequate terminal time, hardware reliability, and training. He feels that it is important that novice users not have an initial bad experience with malfunctioning equipment.

STAFF

One key individual who has the interest is the most important factor in initiating and promoting a good computer program. The individual must be given enough flexibility to experiment and develop the program without interference from the administration, yet maintain accountability. A good individual is more important than organization and funding at the beginning. Too much structure and red tape can kill any good intentions.

Contact

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Bruce Alcock
Director, Computer Center

Barbara Kuper
Administrative Assistant

References

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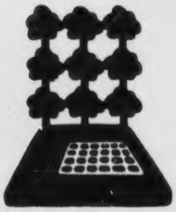
LAWRENCE HALL OF SCIENCE (LHS)
BERKELEY, CALIFORNIA



Computing at Lawrence Hall of Science . . .

Lawrence Hall of Science is a science center where the general public can learn about and use computers.

Profile

DESCRIPTION

Lawrence Hall of Science is a research center in science education on the campus of the University of California, Berkeley.

The building, completed in 1967, houses an exhibit area, a library, planetarium, auditorium, classrooms, laboratories, a cafeteria and a computer center.

GOAL

The main goal of LHS is to increase the general public's awareness and understanding of science by involving people with scientific concepts in a direct, personal and participatory way.

ACTIVITIES

Classes are offered in astronomy, physical and life sciences, mathematics and computing.

Computer-oriented activities comprise the largest public education project at LHS.

VISITORS

LHS had 200,000 visitors in 1977-78. Over 30,000 (15%) came specifically to gain access to supervised computer activities. The majority of the other visitors use computers in exhibits.

COMPUTER EDUCATION PROJECT

The three objectives of the Computer Education Project are:

- To educate adults and children about the world of computers in an enjoyable and non-threatening learning environment.
- To offer the public hands-on computing at low cost.
- To develop an exportable educational program of computer activities that can be replicated in other learning centers and public institutions.

The Past Nine Years

Interest in computing at Lawrence Hall of Science was first generated in 1969 when two programmable calculators were purchased. The first classes for the public, the forerunners of their current program, were offered in 1971.

1969 Received a National Science Foundation grant to purchase two programmable desk-top calculators for the public exhibit areas and teacher workshops.

1970 Purchased an 8-terminal Data General NOVA time-sharing minicomputer with the help of another grant from the National Science Foundation.

Acquired two minicomputers on short-term loan.

Acquired a 32-terminal Hewlett-Packard computer system leased by Berkeley Unified School District; accessed the 16 unused terminals; maintained and programmed the computer and developed curricula for local teachers.

1971 Offered classes, workshops and field trips for local students.

Assumed the Berkely USD computer lease and began selling time to several schools.

Purchased NOVA 800, bringing total computing capacity to 50 terminals.

Hired an engineering staff to take over equipment maintenance and to construct low-cost modems.

Created positions for applications and systems programmers.

Assigned staff member as coordinator of the LHS Computer Education Project.

Initiated programming classes for children.

1972 Perceived a need for a multi-language computer for work with younger children.

1973 Leased multi-language Hewlett-Packard computer.

Installed CRT terminals in the exhibit area.

1974 Initiated a joint CAI project with the California School for the Deaf.

Served over 9000 students in a year.

1975	Taught special classes for gifted students.
	Sold computer time to the public for $1/hour.
	Provided time-sharing service to 30 educational institutions.
1976	Allocated ports to LHS members for home use.
1977	Purchased microcomputers for experimental projects and classes.
1978	Awarded NSF grant to develop "computer-assisted science exhibits" based on microcomputers.
	Initiated a mobile van program to bring 12 personal computers to schools and other institutions to teach Lawrence High School workshops and classes on-site.

Organization and Management of Computing Activities

Computer use at LHS is 80% instructional and 20% administrative.

MANAGEMENT

Arthur W. Luehrmann, Associate Director of LHS and Director of Computer Education and Operations, is responsible for all computing activities. He reports directly to the Director of LHS.

STAFF

In addition to Dr. Luehrmann, the staff for computing activities includes 12 full-time employees and approximately 30 part-time student teachers from the University of California. Personnel form four groups:

- Computer Education Project (CEP)
- Applications Programming
- System Programming, Operations and Engineering
- Computer Access for Schools

Costs and Budgeting

FUNDING

All equipment except the original NOVA computer was purchased from internal operating funds and revenue generated by the LHS computer operation.

BUDGET HISTORY

1976-77	$285,000
1977-78	$450,000

These figures are the total expenditures for the LHS computer group and include staff, equipment, maintenance, and supplies.

Public Access to Computing

COMPUTERS

Three Data General Eclipse S/130
Data General NOVA 1200
Access to DEC PDP 11/70 at the University of California, Berkeley
Three Processor Technology SOL
Fifteen Commodore PET
Sixteen Apple II

The computers operate 24 hours per day.

TERMINALS

100 terminals at LHS and 20 other locations including 5 terminals in the LHS public exhibit area.

Two Commodore PETs in the exhibit area and the cafeteria.

Three graphics terminals.

USERS

1,000 students/year participate in tuition classes.

14,000 adults and children/year rent computer time.

6,000 in workshops for school classes to introduce them to computers.

550 students/year in specially tailored classes.

7,000/year make single visit to LHS and use the computing equipment.

LHS Visitors. Terminals are available in the public exhibit area for visitors (at no cost). Two terminals are incorporated into an energy exhibit and are used to simulate home heat flow and transportation costs per passenger. Three terminals have a menu of activities providing introductory experiences interacting with a computer.

General Public. Supervised computer time in a public area may be rented for $2.00/hour. Users are not restricted to specific applications and may write their own programs; ports have been reserved for home subscribers.

Students and Teachers. Numerous classes and workshops offered throughout the year. Special activities are available for gifted children and students with an avid interest in computing.

Network Subscribers. Students and teachers in 20 schools use the LHS system for academic computing. LHS staff provides support and development of computer-based curriculum for these users.

Tuition Classes at LHS. During the summer of 1978, 100 courses were offered. In addition to those listed above, new courses included Computing Without Numbers, Computing for Girls and How to Get the Most From Your PET. The fifteen recently acquired PETs are being used in 18 of the courses. Thirty full-time student teachers are the instructors for the courses (one instructor for every 5-8 students).

IMPACT

30,000 people are exposed to computers at LHS each year.

Students and teachers in 20 schools use LHS computers at their school sites.

Numerous educators consult LHS regarding educational computing activities.

Computer Literacy

FOR: Visiting school children on field trips and in classes.
General public—visitors and members of LHS.

BY: Computer Education Project staff composed primarily of student teachers from the University of California, Berkeley.

SINCE: 1972

PROGRAM

Workshop. Students have the opportunity to use a terminal that communicates with a computer. Visitors play learning games, attempting to "beat" the computer as they use math and reading skills, problem solving and general game strategies. Instructors provide individual help.

Introduction to Computers. The class explores the computer as an artistic, expressive and recreational medium. Students learn to control the computer by programming for the electronic graphics plotter which produces myriad geometric designs. Activities lead to an introduction to PILOT, a quickly mastered computer language which offers children the rewards of communicating their ideas through the computer.

Programming in PILOT. Students learn to program proficiently in PILOT, an easy to learn, non-algebraic language. Concepts learned in this class provide an excellent foundation for programming in BASIC and other more advanced computer languages.

Math and Computers. Students study mathematical concepts and problem solving techniques which prepare them for beginning programming. As a concept such as coordinate systems is introduced, computer activities follow which exemplify and reinforce the concept. Topics lead to the introduction of programming in PILOT at the end of the course.

Programming in BASIC. After an introduction to computer materials and methods, students learn the programming language, BASIC. BASIC is the most widely used interactive programming language in education and is used professionally world-wide.

After school the varied resources of the Lawrence Hall of Science become available to children and adults who wish to explore topics in math and computers. Offered on a first-come, first-served basis, these classes provide an exciting and enjoyable exposure to math and computer activities:

Creative Play with the Computer. An opportunity to explore the computer as an artistic, expressive and recreational medium.

Beyond Creative Play. Students learn problem solving techniques that prepare them for beginning programming.

PILOT Your Own Computer. Students learn to program the computer in PILOT, an easy to learn, non-math-oriented computer language.

Computer Programming in BASIC. An exploration of advanced topics in computer science.

Computer Exploration for Adults. An easy to understand exploration of computers and how they are used in our society.

Computing Without Numbers. A non-numeric approach to computing in BASIC.

Computing for Girls. An introduction to computer programming, hardware, and career opportunities; specifically planned for girls.

Advanced Use of Personal Computers. An opportunity for experienced programmers to explore and exploit the full capabilities of the new "home computers."

Classroom Uses of Computers. An opportunity for teachers and school administrators to learn about computers and how they can be used to enrich the students' educational experiences.

Programming in 8080 Assembly Language. An introduction to 8080 Assembly Language with an emphasis on more advanced programming techniques.

Outreach

COMPUTER-BASED LEARNING MATERIALS

There are currently three main computer-based curriculum development efforts at Lawrence Hall:

Computer Education Project. Materials developed in this project have been primarily used in classes taught at LHS. As these materials are refined and tested, they will be available to other institutions (e.g., the curriculum for the course, "Creative Play with the Computer"). An earlier version of "Creative Play" was used as the basis for starting a similar computer literacy program administered by the assistant director of the computing center at the University of Utah two years ago.

Project SABLE (Systematic Approaches to Biological Laboratory Explorations). These materials are being used at various colleges in California. They have been used at the University of California, Berkeley, and are being marketed nationally. The package includes a computer-simulated laboratory, called GENIE, that provides students with practice using a scientific approach to solving problems.

California School for the Deaf (CSD). The materials include 600 lessons, many in reading and language, especially geared to hearing-impaired learners. These materials are being used at the California State School for the Deaf in Berkeley. A federally funded teacher in-service program has introduced teachers of the audibly handicapped from all over the San Francisco Bay Area to these materials. LHS and CSD wish to share their experiences and the resulting materials with other institutions. Included in the package are:

- Samples of teacher-authored lessons.
- Reference manuals for LHS student and author programs.
- Copy of directory of the program available at CSD.
- Printouts of the actual programming for any of the programs mentioned herein.
- Paper tapes of the programs (can only be used for computer systems with compatible language).
- Assistance in implementation on other systems.

A small fee is required to cover handling and mailing costs. Otherwise, this service is free. The only stipulation for use of these materials is acknowledgement that the design of the materials is that of the Regents of the University of California and the California School for the Deaf, Berkeley. (All materials copy-righted 1975.)

A new project is the Program of the Month—a service to distribute at reasonable cost one program per month for the PET computer.

COMPUTER FACILITIES

LHS provides a time-sharing service for more than 35 schools and educational institutions in Northern California. Included among these are a Montessori school in San Francisco, high schools in Richmond, Crockett, Piedmont, and Marin, the California School for the Deaf, Two School for Boys in San Francisco, Head-Royce School in Oakland, the California Maritime Academy in Vallejo, Dominican College in San Rafael, and others. On the University of California's Berkeley campus, terminals are installed in several departments. Time-sharing services are also offered to home users. LHS has been sharing time to schools since 1971, and home usage has been available for the past year. Figures 1 and 2 show the cost of hooking up to the system.

EXPERTISE

LHS shared computer expertise with similar institutions at the last meeting of the Association of Science Technology Centers held at Lawrence Hall in May, 1977. Two computer-related workshops were offered at that meeting, both organized by LHS personnel.

COMMUNITY SERVICES

LHS hosted a Computer Expo in 1974 and 1975. Student users were responsible for organizing this event in 1975.

LHS staff taught a five-week course in BASIC language programming for employees of the City of San Jose. The course stressed the fundamentals of programming common to all languages and the development of specific programming skills in BASIC directed toward the computer facilities and work environment of the participants. Students learned BASIC applications for all the computer systems available for use at City Hall.

Now you can really let our computer have it...

Put a convenient typewriter style terminal in your home with an acoustic coupler, dial the Lawrence Hall computer, and really give it the business –

Give it homework, challenge it to learning games, toss it cross assemblies for micro computers, give it nasty statistics, fight galactic empires, learn to program on it, load it with problems . . . it'll take it.

The one thing it doesn't take is a fortune:

special home rates for Lawrence Hall members
7 days a week

morning	7am - 12 noon	$40/month
afternoon	12 noon - 5pm	$40/month
evening	5pm - 10pm	$40/month
night	10pm - 7am	$25/month

reductions for 12 month term
additional charge for private program storage

Telephone Peggy Allison or Lee Berman for full details at (415) 642-3167.

Consumer Warning: This is a high powered interactive educational computer system.

It may give as good as it gets.

X=¯2, Y=¯3
yes....no
YOU WON!

Figure 1

Lawrence Hall of Science

Rates for Educational Computer Services to Schools and Other Qualifying Organizations

Effective July 1, 1978

Data General Eclipse System

Charges Per Lease-line or Dedicated Dial-up Port	Rental Period 12 Months	 10 Months
First terminal	$180/mo.	$200/mo.
2nd-5th terminal at same site	162	180
Additional terminal at same site	144	160
On-line disk storage	$0.20 per 1000 stored characters/mo.	

Digital Equipment 11/70 Unix System

Charges Per Lease-line or Dedicated Dial-up Port	Rental Period 12 Months	 10 Months
First terminal	$250/mo.	$275/mo.
2nd-5th terminal at same site	225	250
Additional terminal at same site	200	225
On-line disk storage	$0.01 per 1000 allocated characters/mo.	

Lawrence Hall service calls on customer-owned communication equipment	$20 per hour portal to portal

Notes

Port charges include the cost of using the computer and the cost of using any communication equipment at the **computer** site.

Port charges do **not** include the cost of a computer terminal, nor the cost of telephone service between the terminal and the computer, nor the cost of communication equipment attached to the terminal, nor maintenance of such equipment. The Lawrence Hall will advise users concerning sources for such equipment and services.

The Lawrence Hall guarantees that computer service will be available each month at least 97% of the time from 9:00 a.m. until 6:00 p.m., Monday through Friday, and at least 90% of all other time, excluding regularly scheduled maintenance. Failure to perform at these average levels in a given month will result in a proportional reduction in the port charge for that month.

Expressly **excluded** from this guarantee are service losses due to faulty terminals, faulty telephone service, or faulty communication equipment attached to the terminal.

For further information, telephone or write to LEE BERMAN at:

Lawrence Hall of Science
University of California
Berkeley, California 94720
(415) 642-3167

Figure 2

Plans and Goals

EQUIPMENT

LHS has recently upgraded the central processing units of their time-sharing minicomputers.

CLASSES

LHS will continue to expand the computing opportunities for non-mathematical students and female studehts.

Lessons Learned

USE

The computer exhibits are the most popular in the museum. Although only a small percentage of LHS visitors read the written text describing exhibits, people will read and follow instructions when they are presented on a computer or terminal. Visitors, in general, enjoy interacting with computers.

Computer classes are the most popular of the LHS programs. LHS staff have learned that there is no one "right" way to teach people about computers or programming. They believe that people can quickly learn to write an original computer program once any initial apprehension is overcome. Staff have observed that adults are often more reluctant than children to sit down at a terminal. For this reason they often recommend that a parent and child team or a family group work together on a terminal. The philosophy at LHS is that learning programming involves learning problem solving strategies which can transfer to other activities.

Computing has proved to be a very effective tool in the education of deaf students.

STAFF

University students are excellent teachers in public access computer projects. The students are not only enthusiastic, but also are knowledgeable about the latest technology.

EQUIPMENT

Graphics equipment and color terminals enhance the enjoyment of computer activities.

Contacts

Lawrence Hall of Science University of California, Berkeley Berkeley, CA 94720 (415) 642-3167	Arthur Luehrmann Director of Computer Education and Operations Lee Berman Network Coordinator Joyce Hakansson Computer Education Coordinator Pete Rowe Applications Programmer
Burdick Group 1620 Montgomery Street San Francisco, CA	Bob Kahn

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Glossary

ACM

Association for Computing Machinery.

ADCIS

Association for the Development of Computer-Based Instructional Systems.

AEDS

Association for Educational Data Systems.

Author Language

A simplified programming language designed for teachers to use to develop computer-based instructional material.

Batch Processing

A traditional mode of data processing. As distinguished from interactive computing, the program executes without user interruption.

CIS

Career Information System. A information storage and retrieval system developed in Oregon. It contains information on careers and higher education in northwestern United States.

Compiler

A computer program which translates other programs into machine readable code.

Computer Assisted Instruction

Learning materials that a student accesses via a computer terminal.

Computer Assisted Testing

Tests that are generated, administered and/or scored via computer.

CCC

Computer Curriculum Corporation

Computer Graphics

Pictures and line drawings generated by the computer and displayed on terminals or plotters.

Computer Literacy

Whatever a person needs to know and do with computers in order to function competently within our society.

Computer-Managed Instruction (CMI)

Use of the computer to manage the instructional process; may include testing diagnosis, prescription of materials or activities, and/or maintenance of student records.

CPU

Central processing unit of a computer.

CRT

Cathode ray tube, a common type of computer terminal.

CVIS

Computerized Vocational Information System, IBM's career and college information retrieval system.

DEC

Digital Equipment Corporation.

DECUS

DEC Computer Users Society.

Disk

A direct access peripheral device that stores programs and data for a computer system.

Drill and Practice

A kind of instructional computer program that presents students with practice problems, checks their answers, and provides them with information about their performance.

GE

General Electric.

GIS

Guidance Information System. Career and college information retrieval system developed and marketed by Timeshare Corporation.

Hardware

The machinery and equipment associated with a computer system.

HP

Hewlett Packard

IMSAI

A brand of microcomputer

Interactive Computing

Students communicate with a computer via terminals. The computer processes student input and responds on demand.

Keypunch

A machine which punches coded holes in cards to be used as input to a computer..

Line Printer

A computer output device that prints a line of letters or symbols at one time.

Microcomputer

A small computer with a miniaturized central processing unit.

NAUCAL

National Association of Users of Computer Applications to Learning.

NCTM

National Council of Teachers of Mathematics.

NEA

National Education Association.

NSF

National Science Foundation.

OMEC

Oregon Mathematics Education Council.

PDP

A series of computers manufactured by Digital Equipment Corporation.

PET

A microcomputer manufactured by Commodore.

Plotter

A computer-controlled device for drawing graphs and pictures.

Network

Terminals and computers connected together via communication lines, allowing for use of the computer by people physically distant from the machines.

Port

The capability at the central computer that allows a remote user to communicate into the computer. Only one user per port may access the computer at any one time.

Programmable Calculator

A calculator that can store and execute a series of instructions written in a special programming language.

Software

Computer programs that control the functions of the computer equipment. Software is also a general term for any computer program (as opposed to hardware).

SOL

A microcomputer manufactured and sold by Processor Technology, Inc.

Strand

A series of drill and practice items on one topic (e.g., addition, contractions, spelling, fractions).

Strands Approach

The pedagogy of several computer-based curriculum packages developed at Stanford University and now marketed by the Computer Curriculum Corporation. A curriculum covers several years (e.g., K-6) in one discipline area (e.g., mathematics) and addresses 10-20 topics, or strands. Students registered in the curriculum are able to move at their own pace in each strand. A student's session using the drills may include items from several strands.

Tandy TRS-80

A microcomputer sold by Radio Shack Corporation

Teletype (TTY)

A computer terminal resembling a typewriter (trade name of Western Electric.)

TTY

Teletypewriter.

Terminal

A device used for interacting with a computer.

TI

Texas Instruments, a manufacturer of computers and other electronic devices.

Time-Sharing

Concurrent use of one computer by many users.

VOTRAX

An electronic voice synthesize that can speak words and can be controlled by computer.

Word Processing

Typing, formatting, editing, and performing other similar activities with the written word. The computer plays a major role in many word processing applications.

APPENDIX:

CASE STUDY AND EXEMPLAR INSTITUTIONS

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Case Study

The following educational institutions have been selected to participate as Case Studies in Academic Computing.

The persons to contact regarding academic computing at the Case Study institutions are identified in the *Academic Computing Directory* published by HumRRO.

North Salem High School, Salem, Oregon
George Washington High School, Denver, Colorado
Lincoln High School, Bloomington, Minnesota
Ridgewood High School, Ridgewood, New Jersey
Riverdale Country School, Bronx, New York
Huntington Beach Union High School District, Huntington Beach, California
Alexis I. DuPont School District, Greenville, Delaware
Chicago Public Schools, Chicago, Illinois
Dallas Independent School District, Dallas, Texas
Lawrence Hall of Science, Berkeley, California
William Rainey Harper Community College, Palatine, Illinois
Golden West Community College, Huntington Beach, California
United States Naval Academy, Annapolis, Maryland
Worcester Polytechnic Institute, Worcester, Massachusetts
Denison University, Granville, Ohio
Evergreen State College, Olympia, Washington
Jackson State University, Jackson, Mississippi
Mankato State University, Mankato, Minnesota
Rutgers, The State University, Piscataway, New Jersey
University of Delaware, Newark, Delaware
University of Texas, Austin, Texas

Exemplar Institutions

Educational institutions identified here are participating in the study, "Exemplary Institutions in Academic Computing." These institutions have been selected as Exemplars in one or more Categories of Excellence, on the basis of written responses to a series of questionnaires prepared by the Human Resources Research Organization.

Individuals to contact regarding academic computing at the Exemplar institutions, may be found in the *Academic Computing Directory* published by HumRRO.

CATEGORY 1: STUDENT ACCOMPLISHMENTS

Colleges and Universities With Student Enrollment Over 6,000 FTE

University of California, Irvine (CA)
University of Akron (OH)
University of Pittsburgh (PA)
University of Texas, Austin (TX)

Colleges and Universities With Student Enrollment Under 6,000 FTE

University of D.C., Van Ness
Grinnell College (IO)
Transylvania University (KY)
U.S. Naval Academy (MD)
Worcester Polytechnic Institute (MA)
Bennett College (NC)
Denison University (OH)
Evergreen State College (WA)

Community Colleges

Gavilan College (CA)
Golden West College (CA)
William Rainey Harper College (IL)
Burlington County College (NJ)

Elementary and Secondary Schools

George Washington HS (CO)
Baliou HS (DC)
Hull HS (MA)
Joyner Elementary School (NC)
Amherst Central Senior HS (NY)
Riverdale Country School (NY)
Belmont HS (OH)
North Salem HS (OR)
Sehome HS (WA)

Public School Districts

Huntington Beach USD (CA)
Los Nietos ESD (CA)
Montgomery County PS (MD)
School District of Kansas City (MO)
Syosset Central SD (NY)
Woodridge PS (OH)
Memphis City Schools (TN)
Dallas ISD (TX)
Richardson ISD (TX)
Jordan SD (UT)
Fairfax PS (VA)
Highline SD (WA)

Public Access

Capital Area Career Center (MI)

CATEGORY 2: INSTITUTION ACCOMPLISHMENTS

Colleges and Universities With Student Enrollment Over 6,000 FTE

New York Institute of Technology (NY)
University of Pittsburgh (PA)
University of Texas, Austin (TX)

Colleges and Universities With Student Enrollment Under 6,000 FTE

Trinity College (CT)
University of Tennessee, Chattanooga (TN)
Trinity University (TX)
Carnegie-Mellon (PA)

Community Colleges

Golden West College (CA)

Elementary and Secondary Schools

Ballou HS (DC)
Garden City HS (KS)
Lincoln HS (MN)

Public School Districts

Huntington Beach USD (CA)
Atlanta PS (GA)
Chicago PS (IL)
Albuquerque PS (NM)
Jamesville-DeWitt CSD (NY)

CATEGORY 3: SPECTRUM OF COMPUTER APPLICATIONS TO LEARNING AND TEACHING

Colleges and Universities with Student Enrollment Over 6,000 FTE

Auburn University (AL)
California State at Fresno (CA)
Stanford University (CA)
University of Colorado, Boulder (CO)
University of Delaware (DE)
Southern University and A&M College (LA)
Mankato State University (MN)
Rutgers University (NJ)
Ohio State University (OH)
University of Pittsburgh (PA)
University of Texas, Austin (TX)
University of Texas, El Paso (TX)
Western Washington University (WA)
University of Wisconsin, LaCrosse (WI)

Colleges and Universities With Student Enrollment Under 6,000 FTE

Colorado School of Mines (CO)
Fairfield University (CT)
Trinity College (CT)
Anderson College (IN)
Grinnell College (IO)
Emporia State University (KS)
U.S. Naval Academy (MD)
Carleton College (MN)
Northern Montana College (MT)
Worcester Polytechnic Institute (MA)
Dartmouth College (NH)
Hamilton/Kirkland College (NY)
Bennett College (NC)
University of North Carolina, Asheville (NC)
Denison University (OH)
Bucknell University (PA)
University of Tennessee, Chattanooga (TN)
University of Tennessee, Martin (TN)
Trinity University (TX)
Evergreen State College (WA)
University Wisconsin, Superior (WI)

Community Colleges

Golden West College (CA)
William Rainey Harper College (IL)
St. Louis CC, Florissant Valley (MO)
Broome County CC (NY)
Roane State CC (TN)

Elementary and Secondary Schools

George Washington HS (CO)
Garden City HS (KS)
Lincoln HS (MN)
Maple Lake HS (MN)
Ridgewood HS (NJ)
Teaneck HS (NJ)
Commack HS South (NY)
Jericho HS (NY)
Joyner Elementary School (NC)
West Cary Jr. HS (NC)
Belmont HS (OH)
Catlin Gabel School (OR)

Public School Districts

Huntington Beach USD (CA)
Palo Alto SD (CA)
San Francisco Unified SD (CA)
Chicago Public Schools (IL)
Wichita PS (KS)
Jamesville-DeWitt CSD (NY)
Dallas ISD (TX)

CATEGORY 4: COMPUTER LITERACY PROGRAMS FOR STUDENTS, FACULTY OR COMMUNITY

Colleges and Universities With Student Enrollment Over 6,000 FTE

Auburn University (AL)
University of California, San Diego (CA)
Mankato State University (MN)
Rutgers University (NJ)
University of Illinois, Urbana (IL)
New York Institute of Technology (NY)
University of Texas, Austin (TX)
University of Texas, El Paso (TX)
University of Wisconsin, LaCrosse (WI)

Colleges and Universities With Student Enrollment Under 6,000 FTE

Colorado School of Mines (CO)
Fairfield University (CT)
Grinnell College (IO)
U.S. Naval Academy (MD)
Carleton College (MN)
Northern Montana College (MT)
Dartmouth College (NH)
Bennett College (NC)
Denison University (OH)
Cameron University (OK)
Bucknell University (PA)
Moravian College (PA)
University of Tennessee, Chattanooga (TN)
Trinity University (TX)
Evergreen State College (WA)

Community Colleges

Gavilan College (CA)
Mercer County CC (NJ)

Elementary and Secondary Schools

George Washington HS (CO)
St. Patrick HS (IL)
Lincoln HS (MN)
Maple Lake HS (MN)
North Salem HS (OR)
Teaneck HS (NJ)
Amherst Central Senior HS (NY)
Riverdale Country School (NY)

Public School Districts

Huntington Beach USD (CA)
Palo Alto USD (CA)
San Jose USD (CA)
Alexis I. DuPont (DE)
Montgomery County PS (MD)
Albuquerque PS (NM)
N. Syracuse Central SD (NY)
Dallas ISD (TX)
Richardson ISD (TX)
Fairfax County PS (VA)
Highline SD (WA)

Public Access

Lawrence Hall of Science (CA)

CATEGORY 5: COMPUTER SCIENCE OR DATA PROCESSING CURRICULA

Colleges and Universities With Student Enrollment Over 6,000 FTE

California Polytechnic State University,
San Luis Obispo (CA)
Mankato State University (MN)
Western Washington University (WA)
University of Colorado, Boulder (CO)
Rutgers University (NJ)
Ohio State University (OH)
University of Texas, Austin (TX)
University of Wisconsin, LaCrosse (WI)

Colleges and Universities With Student Enrollment Under 6,000 FTE

Anderson College (IN)
U.S. Naval Academy (MD)
Worcester Polytechnic Institute (MA)
University of North Carolina, Wilmington (NC)
State University of New York, Plattsburgh (NY)
Bucknell University (PA)
Carnegie-Mellon (PA)

Community Colleges

William Rainey Harper College (IL)
St. Louis Community College, Florissant Valley (MO)
Burlington County College (NJ)
Mercer County College (NJ)
Roane State Community College (TN)

Elementary and Secondary Schools

George Washington HS (CO)
Ballou HS (DC)
Hull HS (MA)
Belmont HS (OH)
N. Salem HS (OR)
Ridgewood HS (NJ)
Teaneck HS (NJ)
Amsterdam HS (NY)
Commack HS South (NY)
Riverdale Country School (NY)
Sehome HS (WA)

Public School Districts

Jefferson County PS (CO)
Alexis I. DuPont SD (DE)
Atlanta PS (GA)
Chicago PS (IL)
Albuquerque PS (NM)
Churchill Area SD (PA)
Dallas ISD (TX)
Fairfax County PS (VA)

CATEGORY 6: OUTREACH TO COMMUNITY AND OTHER INSTITUTIONS

Colleges and Universities With Student Enrollment Over 6,000 FTE

California State, Fresno (CA)
University of California, Irvine (CA)
University of Illinois, Urbana (IL)
Mankato State University (MN)
Jackson State University (MS)
University of North Dakota (ND)
University of Akron (OH)
Ohio State University (OH)
University of Pittsburgh (PA)
University of Texas, Austin (TX)
Western Washington University (WA)
University of Wisconsin, LaCrosse (WI)

Colleges and Universities With Student Enrollment Under 6,000 FTE

Fairfield University (CT)
Lewis University (IL)
Grinnell College (IO)
U.S. Naval Academy (MD)
Worcester Polytechnic Institute (MA)
Northern Montana College (MT)
Dartmouth College (NH)
University of North Carolina, Asheville (NC)
Denison University (OH)
Bucknell University (PA)
University of Tennessee, Chattanooga (TN)
Rice University (TX)
Evergreen State College (WA)

Community Colleges

Maricopa Community College District (AZ)
Gavilan College (CA)
Golden West College (CA)
Burlington County College (NJ)
Mercer County Community College (NJ)
Roane State Community College (TN)

Elementary and Secondary Schools

George Washington HS (CO)
Canterbury School (CT)
Ballou HS (DC)
St. Patrick HS (IL)
Hull HS (MA)
Ridgewood HS (NJ)
Riverdale Country School (NY)
Belmont HS (OH)
Catlin Gabel (OR)
Upper St. Clair HS (PA)
Sehome HS (WA)

Public School Districts

Huntington Beach USD (CA)
Los Nietos ESD (CA)
San Francisco Unified SD (CA)
Jefferson County PS (CO)
Alexia I. DuPont SD (DE)
School District of Kansas City (MO)
Wayne Township PSD (NJ)
Jamesville-DeWitt CSD (NY)
Churchill Area SD (PA)
Dallas ISD (TX)
Fairfax County PS (VA)

Public Access

Lawrence Hall of Science (CA)
Capital Area Career Center (MI)